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The Commonwealth of Massachusetts.

STATE BOARD OF AGRICULTURE.

ECONOMIC BIOLOGY—BULLETIN No. 1.

December, 1914.

RATS AND RAT RIDDANCE.

By EDWARD HOWE FORBUSH,
State Ornithologist.

From the Sixty-second Annual Report of the Massachusetts State Board of Agriculture.

BOSTON:
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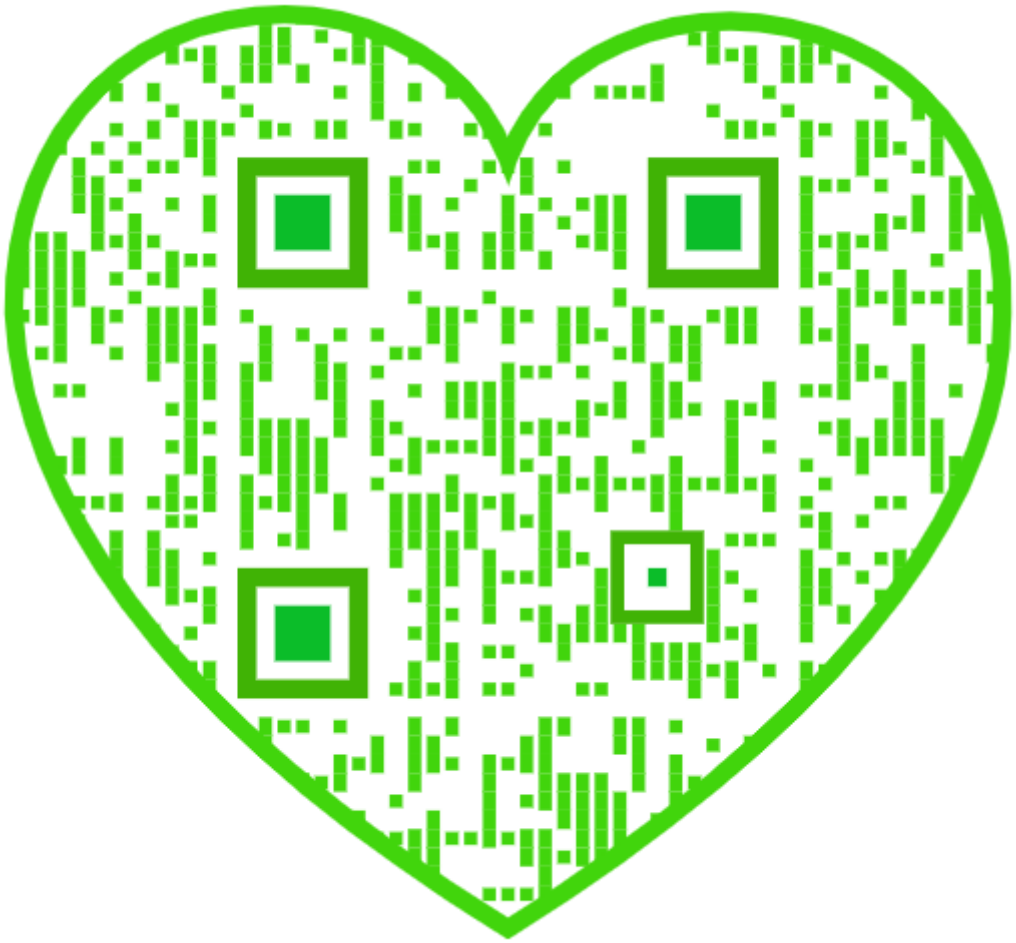

DEC 31 1915

The Most
Expensive Animal
that Man Maintains; Fore-
runner of Famine, Disease, and
Pestilence. Disseminator of the
Dreaded Trichina and the TERRIBLE BU-
BONIC PLAGUE or "BLACK DEATH," which has
slain its miserable horror-stricken millions since the
dawn of history, and now has spread to the United States.

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Approved by
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PREFATORY NOTES.

It may be asked why the State Ornithologist should write a bulletin on rats. In reply to this it may be said that economic ornithologists as such are especially interested in the destruction of rats for two reasons: (1) rats are very destructive to the eggs and young of birds, whether wild, captive or domesticated; (2) many people who have given up keeping cats because of bird-killing habits now wish to know how to get rid of rats. Hence, the suppression of rats becomes a problem for the economic ornithologist. In 1912 Mr. J. Lewis Ellsworth, then secretary of the State Board of Agriculture, deemed these reasons sufficient to propose the preparation and publication of a bulletin on rats and rat riddance. The proposition was enthusiastically received by the members of the Board, the task naturally fell to the State Ornithologist, and here is the bulletin.

In the experimental work undertaken during the last two years as a preparation for the publication of this bulletin thousands of rats have been destroyed. The exact number cannot be given, owing to the fact that chemical poisons and fumigants were used in some cases, and where such methods are utilized the exact number killed cannot be ascertained.

The author takes pleasure in acknowledging his great indebtedness to the excellent publications on rats issued by the Biological Survey of the United States Department of Agriculture, and particularly to Prof. David E. Lantz of the Survey, the author of these and other rat papers, who has furnished many facts contained in this bulletin, for his kind assistance and for valuable information received from him personally.

The author is equally indebted to the Public Health and Marine Hospital Service of the United States Treasury Department for valuable publications, to Surgeon-General Rupert

Blue of that service for many courtesies, including the use of electrotypes; also to Assistant Surgeon-General William Colby Rucker and Surgeon Richard M. Creel for photographs, and to all these gentlemen and Passed Assistant Surgeon J. R. Hurley for valuable and authoritative information.

The small line cuts illustrating this bulletin were made from pen sketches by Mr. Walt F. McMahon.

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RATS AND RAT RIDDANCE.

INTRODUCTION.

With the lapse of ages the rat has become a parasite on man. It has developed into the greatest rodent pest ever known. It is far more destructive, directly or indirectly, to human life and property than any wild beast or venomous serpent. It appropriates nearly everything that man eats, and drinks many of his beverages. It follows him with its baleful influence from the cradle to the grave. It destroys his poultry and molests his domesticated animals. It has been known to attack and mutilate infants, sleepers, the sick, aged and infirm. It is the forerunner of famine, pestilence and death. It carries the germs of disease. It infects man's ships and habitations with the dreaded plague; sets fire to his dwellings and ships, and ceases its ravages only when the house burns or the ship sinks. As if not satisfied with pursuing him through life, it follows him in death, desecrating and mutilating his mortal remains.

It is the duty of all nations to take part in the destruction of this abominable pest. Dr. William Colby Rucker, Assistant Surgeon-General, Public Health and Marine Hospital Service of the United States, says that we must work and we must teach, and so bring about an antipathy toward the rat greater than the present antipathy toward the snake. Also, we must inculcate the lesson that "the rat is the most expensive animal that man maintains," and that its suppression and control are as important from an economic as from a humanitarian standpoint.

RAT HISTORY.

House rats and mice came to America in ships from the Eastern Hemisphere. They belong to the old world genus *Mus*. The house mouse (*Mus musculus*) may be regarded as a small rat, as it has similar habits; the black rat (*Mus rattus*) is medium in size, and the brown, Norway or wharf rat (*Mus*

norvegicus) now the common rat of New England, is the largest, sometimes reaching a length of nineteen inches, including the tail. I have seen one taken that weighed nineteen ounces, possibly they may grow much larger,[1] but those commonly seen are smaller. In New England this species is by far the greatest pest of all.

The house mouse reached New England soon after its settlement, and the black rat had become well established here early in the eighteenth century. From that time until long after the American Revolution it was the common house rat of America; but the arrival of the cannibal brown rat, in the latter part of the eighteenth century, doomed the black rat to extirpation. Here, as in Europe, the latter was driven out by the former, and now the black rat is found only in small numbers, and in regions remote from coasts and large cities. Black rats were common about 1870 in towns of central Worcester County, Massachusetts, where now they have been extinct for years, but there are still a few left in some interior towns.

No one positively knows the native country of the brown rat. Probably it did not originate in Norway, Persia or India, as some writers have asserted, and it seems to have been unknown to early Europeans. It is said to be practically unknown in Persia, and is found in India mainly near the coast and on the navigable rivers. The black rat is far more widely distributed in India than the brown rat. The latter probably is of Asiatic origin, and is said to have reached England from some eastern port about 1728, shortly after it had crossed the Russian frontier from Asia.[2]

RAT HABITS.

The first step toward effective destruction of rats is a study of their habits and food. Rats appear to be naturally nocturnal, as they move about readily in the dark, feeling and smelling their way along walls and into holes and passages. Their ears, noses, "whiskers" (*vibrissæ*) and feet are very sen-

[1] The Field (London, Sept. 20, 1913, p. 666) records the weight of several much larger specimens, as follows: one, 1 pound 13 ounces; one, 1 pound 15 ounces; two, 2 pounds each; one, 2 pounds 8 ounces; and one, 2 pounds 12 ounces. No measurements are given. The English climate must be extremely favorable to the development of the brown rat.

[2] Lantz, David E., U. S. Dept. Agr., Biol. Surv. Bull. 33, 1909, pp. 11–13.

sitive, and serve well to guide them in the dark, but if too closely pursued by nocturnal enemies they can easily change their habits, feeding in daylight and sleeping at night. The brown rat may be seen abroad at any hour, especially at morning and evening. It never likes to go far from some hole or hiding place to which it can retreat at the first sign of danger, and if it has to cross wide fields, it prefers to go through bushes, grass or grain, along some wall or fence, or through or near a ditch, where it can find shelter. In many cases it burrows in the earth in fields, either near water, where it goes to drink, or near its food supplies. Sometimes these burrows are used only as places in which to hide from its enemies, but it often lives all summer (and under some circumstances all winter) in burrows in well-drained banks of rivers or small streams, or along the shores of islands in the sea. The brown rat drinks large quantities of water, and must have water, snow, rain or dew in plenty at all times, hence its preference for banks of streams, ditches, pools and springs. Also it is perfectly at home in water, and can swim rapidly and easily for half a mile or more, and it dives and swims readily under water. It nests and rears its young in burrows in and under buildings and under rubbish piles, and there it also stores more or less food for use in times of want or danger.

Rats live outdoors more in the south than in the north. In rural New England, especially where grain is grown, the brown rat lives chiefly in fields in summer and in and around buildings in winter. In villages and cities rats stay much about buildings all the year, but some migrate into the open in spring and return to the buildings in autumn. Rats migrate in large numbers whenever food fails, crossing deserts and rivers that may lie in their path. Hunger thus accounts for the great invasions of rats that sometimes occur. It is a well-known fact that rats catch and eat mice, but they never can exterminate mice, for the same reason that cats cannot extirpate rats. Mice are so much smaller than rats that they can run into holes where the latter cannot follow. Therefore rats and mice are commonly found in the same buildings or fields. It is not generally known, however, that brown rats are cannibals. The adult male will search out and eat its own offspring; but, on the

other hand, the female will defend her young gallantly. James Rodwell, in an interesting little volume on the rat, containing many facts and some exaggerations, tells of a battle between two rats that he witnessed. Numbers of their companions gathered from all directions. All waited until one was conquered and dying, then fell upon both combatants like a pack of hungry wolves and tore them to pieces.[1] It is a common occurrence for a rat caught and injured in a trap, but not killed outright, to be set upon and eaten by its companions. I have known of many such cases.

The rat is a courageous animal and when cornered usually will face great odds in defense of its life, and fight to the last breath. Not all individuals, however, exhibit the same dauntless courage. There is more difference in rats than appears as they run off.

Dr. Richard H. Creel of the Public Health and Marine Hospital Service of the United States has made some investigations into the habits of rats in their relation to antiplague measures. His investigations furnish useful information to those who wish to rid their premises of rats. Five full-grown brown rats were placed within a stockade made of galvanized iron, sunk three feet into the ground. The rats being confined forty-eight hours failed to burrow under the stockade. No burrow extended downward more than two and one-half feet. Black rats so confined made no attempt to burrow. The brown rat burrows with the greatest ease, even in the hardest packed ground, and has perforated walls of sundried brick held together by sand-and-lime mortar, in some cases actually piercing the body of the brick. The English Plague Commission credits the brown rat with ability to gnaw through brick or concrete, but it is incredible that it can penetrate properly prepared concrete after it once becomes well hardened.

In one of Dr. Creel's experiments a brown rat, in an attempt to scale a stockade, jumped upward and outward a distance of seventeen inches. Black rats jumped upward two feet in their efforts to scale the stockade, and in one instance one of them, confined within a perfectly smooth galvanized-iron can two feet in depth, spiraled its way to the top by a series of

[1] Rodwell, James, The Rat; its History and Destructive Character, 1858, p. 22.

jumps, and escaped. Rats were unable to climb up the inner or outer corner of a concrete building. Three species — the brown rat, the black rat and the roof rat (*Mus alexandrinus*) — climbed a one-inch standpipe and a cocoanut tree with the greatest ease.[1]

Rats have been observed climbing on elevator ropes and cables to the upper stories of the highest buildings, and crossing from building to building on telephone wires. Many authors state that the brown rat is found mainly in the lower parts of buildings and that the black rat and the roof rat seek the upper floors. Nevertheless, black rats go into cellars and brown rats almost always explore the attics of houses, especially those which contain open water tanks; also they have been found in the upper stories of some high buildings.

RAT FOOD.

Rats, like all rodents, are fitted to feed on vegetable matter, grain, hard seeds, roots, nuts, etc., but in the course of time they have become practically omnivorous, eating almost anything edible, and gnawing many substances that have little or no food value.

RAT FECUNDITY.

Possibly no mammal pest is more prolific than the rat. The fabulous speed of its multiplication baffles all but the most

efficient and determined attempts at extermination. Kolazy says that he kept two female white rats in confinement that produced twenty-six litters, or 180 young, within thirteen months. Rodwell says that the female brown rat is believed to bring forth from six to eight litters yearly; but estimating

[1] Creel, Richard H., Public Health Reports, Vol. 28, No. 9, Feb. 28, 1913, pp. 382–385.

that a pair produces only four litters, six in each litter, each rat living three years, he figures that in that time the progeny of one pair would be 651,050.[1] In temperate latitudes the brown rat is now known to breed from three to five times each year, bringing forth from six to twenty young each time. Assuming that the animal breeds but three times a year, and produces on the average ten young at each period, Prof. David E. Lantz estimates that with no deaths the number at the end of the third year would reach 20,155,392 individuals.[2] Dr. William Colby Rucker, Assistant Surgeon-General, United States Public Health Service, computes the theoretical increase of a pair of rats for five years at 940,369,969,152.[3] It is hardly necessary to say that such results as these could not occur in nature, but these figures indicate the immense possibilities of this pest under favorable circumstances. Let mankind rejoice that rats are cannibals.

RAT NUMBERS AND DESTRUCTIVENESS.

If an exact census of the rats in the United States could be taken, their numbers probably would be beyond belief.

Few people realize how many rats infest their premises. Possibly there are none in some localities, but there are very many more in existence than ever are seen by human eyes. The number varies from a few pairs on some well-cared-for estates to hundreds in ratty tenements and farm buildings, and thousands on ill-protected farms and country estates. Rats come and go mysteriously in some localities. There are some large areas in the country where very little grain is raised or used, or where for some other reason rats are not numerous; other regions swarm with them. Farmers or householders, when interrogated, usually admit that they have a few rats. Careful investigation, however, sometimes shows that the farmer suffers an annual loss, equal perhaps to his taxes, because of the grain eaten or wasted by rats in the fields and stolen from his fowls, cattle, horses and hogs, from his stored unthreshed grain, or from barrels and bags in barns or store-

[1] Rodwell, James, The Rat, 1858, pp. 167, 168.

[2] Lantz, David E., U. S. Dept. Agr., Biol. Surv. Bull. 33, 1909, p. 16.

[3] Treas. Dept., Public Health and Marine Hospital Serv. of U. S., The Rat and its Relation to the Public Health, by various authors, 1910, p. 153.

houses, to say nothing of the toll taken from fruit, vegetables, poultry, eggs and other food.

I have visited livery stables the proprietors of which believed that they had but few rats, but careful observation showed that considerable sums were lost yearly through unnoticed thefts perpetrated by numerous rodents that nightly entered the open, unprotected or carelessly closed grain bins, and daily fed in the mangers with the horses. These gentlemen relied on wandering cats that had taught the rats to keep out of sight.

Rats are numerous in cities and villages, particularly in grocery, provision and grain stores, warehouses and grain mills, and many proprietors of these places practically have given up trying to repress them, and have resigned themselves to serious losses.

Rats multiply most rapidly if well fed, sheltered and little molested. They find favorable conditions on farms where grain is grown. In 1901 a country estate of 2,000 acres near Chichester, England, was so badly infested by rats that 31,981 were killed within five years, under the supervision of the owner, and it was estimated that the tenants, while threshing the grain, had killed 5,000 more.[1]

In Jamaica in one year 38,000 rats were killed on one plantation.[2]

Farm holdings in England often were, and still are, badly infested. Rodwell says that a boy in Shropshire killed 630 rats in about four months, and it was computed that there were at least 1,260 rats on this farm of 280 acres. On another farm, of 400 acres, when the barn was emptied, after the threshing, over 1,400 rats were killed, and numbers escaped into drains and rabbit holes. On another place, of 180 acres, a boy was employed with six or eight traps, who caught five or six rats each night during the winter months, and at the emptying of one barn 800 more were killed, making in all 1,340 rats. On an estate, of 330 acres, 1,095 rats were said to have been killed during the year. A rat catcher of Middlesex, with two ferrets, killed in one barn about 250 rats in one day, and more than 200 were killed there the next day. On another farm he caught

[1] The Field (London), Vol. 100, Sept. 27, 1902, p. 545.
[2] New Eng. Farmer, Vol. 12, 1834, p. 315.

over 150 rats alive in a small grain rick. Many more were killed and many escaped. A farmer killed more than 700 rats by surrounding a rick with boards and attacking them with a dog.[1]

Buckland says that an official report from the French government asserts that the proprietor of a slaughterhouse killed 16,050 rats in one month.

Rats are very numerous in this country. In Maryland, in 1832 a farmer and his men and dogs killed 217 brown rats from one stack of rye.[2] At The Farm and Trade School at Thompson's Island, in Boston Harbor, a farm of about one hundred and fifty acres, in one day I counted over 800 rat burrows in the fields and along the shores. This was after many rats had been destroyed and a large number of holes closed. Later, about 1,300 rat holes were found open and rats were numerous also in some of the buildings. The pupils of the school previously had caught in traps about 200 rats a month. From June 6 to August 13, 1913, 572 were caught, but this trapping alone hardly kept down the natural increase.

Professor Lantz states that a farmer at Grand River, Iowa, had about 2,000 bushels of corn in three cribs, and that the rats ate and destroyed about one-fourth of the corn. At that time the farmer was poisoning and trapping rats, having killed as many as 300 in two days. The rats ruined more than enough corn to pay taxes on 400 acres of land.[3] The Moline, Illinois "Evening Mail" of April 25, 1904, states that Mr. F. U. Montgomery of Preemption, Mercer County, killed 3,435 rats on his farm. Most of these were caught in traps, between March 20 and April 20, 1904. In a letter written to Dr. C. Hart Merriam by Mr. Alfred Chisholm of Savannah, it is asserted that on two rice plantations in Georgia 47,000 rats were killed during the winter and spring of one year.[4]

Practically all ships have rats, and their numbers increase enormously, despite the cats which are kept on shipboard to destroy them. The losses to ship stores and cargoes by rats are tremendous. The British man-of-war "Valiant" had so many rats aboard in 1776 that they destroyed more than 100

[1] Rodwell, James, The Rat, 1858, pp. 151–156.
[2] Amer. Turf Reg., Vol. 3, Aug., 1832, p. 632.
[3] Lantz, David E., U. S. Dept. Agr., Biol. Surv. Bull. 33, 1909, p. 20.
[4] *Ibid.*, p. 21.

pounds of bread daily. The ship was fumigated, and six hampers were filled every day for some time with dead rats.[1]

Surgeon William C. Hobdy relates that the British steamer "Gadsby" on a voyage of twenty-nine days had 44,000 out of 46,000 bags of wheat in her cargo cut by rats, with an estimated damage of $2,200. He says also that a small vessel (260 tons) was fumigated in San Francisco, after which 310 rats were picked up dead, — "a barrelful and seven." On another larger vessel, fumigated some years earlier at Bombay, 1,300 rats were destroyed at one time, and the steamship "Minnehaha," fumigated at London, England, in May, 1901, yielded 1,700.[2]

Organized efforts to destroy rats have been made in various countries, and the numbers killed give some indication of rat abundance. In 1904 at Folkstone, England, the corporation employees, with the help of dogs, in three days killed 1,645 rats.[3]

A rat hunt at New Burlington, Ohio, November 26, 1866, yielded over 8,000 rats. In this hunt sides were chosen, as at a spelling bee, and the beaten party gave a dinner to the winners.[4] A sparrow club in Kent, England, secured the destruction of 28,000 sparrows and 16,000 rats in three seasons by expending £6 ($29.20) in prizes.[5] An international association for the destruction of rats in Denmark succeeded in getting a government appropriation for its work, under which 1,141,293 rats were killed during the first year, ending July 1, 1908.[6] In Copenhagen 103,000 rats were destroyed in eighteen weeks. In seven years 711,797 were killed in Stockholm.[7]

In the work done in American cities to check the bubonic plague great numbers of rats have been killed, although no correct count of them could be obtained, as both traps and poisons were used, but in the first four months about 130,000 were destroyed in San Francisco. In the early months of 1908, up to May, 278,000 were captured, and it was estimated that 500,000 had been poisoned. In a report of the Indian Famine

[1] Rodwell, James, The Rat, 1858, p. 164.

[2] Treas. Dept., Public Health and Marine Hospital Serv. of U. S., The Rat and its Relation to the Public Health, by various authors, 1910, pp. 208, 209.

[3] The Field (London), Vol. 104, July 16, 1904, p. 98.

[4] Lantz, David E., U. S. Dept. Agr., Biol. Surv. Bull. 33, 1909, p. 51.

[5] Jour. Bd. of Agri., Gt. Britain, Vol. 9, 1902, p. 342.

[6] Jour. Inc. Soc. for Destruction of Vermin, Vol. 1, Oct., 1908, p. 32.

[7] Lantz, David E., U. S. Dept. Agr., Biol. Surv. Bull. 33, 1909, p. 53.

Commission, presented to the British Parliament in 1881, it was stated that a plague of rats infested the Southern Deccan and Mahratta Districts, that rewards were paid for the destruction of the vermin, and that over 12,000,000 were killed.[1] In all these cases the number of rats killed may be regarded merely as an indication of the number in existence. No one knows how many escaped.

Enough has been recorded here to give some idea of the enormous numbers of rats that infest the world, and we may next turn to a consideration of their destructiveness.

Farmers assert that when rats become numerous the injury to crops passes all bounds. They sometimes swarm in grain fields. Corn fields are absolutely ruined by them. They climb the stalks and strip the cobs clear of grain. I have seen much corn destroyed by them in this manner, and Professor Lantz avers that he has seen whole fields thus ruined. A writer in the "American Agriculturist" says that rats destroyed three-fourths of the corn on thirteen acres of land.[2] Rats usually eat only the softer part of the kernel, wasting most of it. Sweet corn is a favorite grain.

It may not be commonly known that rats often dig up seeds which have been planted, and in this way they may become more destructive than crows, squirrels, pheasants or marmots. On Thompson's Island the corn on more than two acres was destroyed in this way in the spring of 1913. There are no squirrels, no pheasants and no woodchucks on the island and crows do not breed there. Ordinarily rats do not trouble peas or beans, but they have been known to dig up quantities of the planted seed and to attack peas and beans, both stacked on farms and stored in Boston warehouses. Large portions of the crops of wheat, rye, barley, oats, etc., are taken by rats and mice in the fields, and when unthreshed grain is stored in barns or ricks rats swarm to it, and if left to themselves they destroy most of the grain. They take large toll from the rice planter and the sugar planter. Enormous quantities of corn and feed stuffs are eaten by rats, a little at a time, in granaries, feed stores, stables, barns and poultry houses. They are fond of malt, and cause the brewers great loss. Great quantities of

[1] British Med. Jour., Sept. 16, 1905, p. 623. [2] Amer. Agriculturist, Vol. 33, 1874, p. 300.

flour and meal in bags are eaten by them, and much more ruined or depreciated in quality by the filth which they distribute. While trapping rats in a dwelling house I found stored in the barn twenty twenty-five-pound bags once filled with flour, nearly all of which had been eaten or ruined by rats.

Small fruits disappear mysteriously, and birds that are known to eat them receive the blame; in many cases rats are the culprits. Rats, like squirrels, can climb bush, tree or vine. Unlike squirrels, rats work mainly in the night and escape notice, but they have been seen taking fruit from trees in daylight.

Dr. L. O. Howard, Chief of the Bureau of Entomology, United States Department of Agriculture, records the fact that in a single afternoon he shot 28 rats from the branches of a cherry tree in Washington, District of Columbia. Rats have been seen to steal cherries in England, and both the black rat and the roof rat are shot in large numbers from the branches of fruit trees and other trees in the south.

Capt. R. R. Raymond, United States Army, asserts that at West Point, New York, when visiting some cherry trees he frequently met rats in the trees on the same errand as himself.[1]

Fruits and vegetables, when stored in buildings and cellars, are attacked by rats. Quantities of grapes, oranges, bananas, figs, dates and cocoanuts, and pods of cocoa from which chocolate is manufactured, are ruined by them. Grapes grown under glass especially are subject to attack. Massachusetts farmers report destruction of apples and potatoes in their cellars in quantities, aggregating hundreds of barrels. Rats are very destructive to tomatoes at times and to melons and squashes, which they appear to gnaw into mainly to obtain the seed, thus ruining far more than they actually destroy. Vegetables and fruits in transit on railroads and steamboats and in freight houses are eaten. Rats destroy cucumbers, sweet potatoes and grapefruit in this way. Rats eat seeds, bulbs, stems and leaves of flowering plants. Florists' greenhouses are invaded by them. Tulips seem to be their favorite bulbs, and there are many tales of the loss of quantities of tulips; hundreds of bulbs are sometimes destroyed by rats

[1] Lantz, David E., U. S. Dept. Agr., Biol. Surv. Bull. 33, 1909, p. 24.

in a single night. Rats destroy pinks (carnations) and roses, of which they seem to be particularly fond; also hyacinths, and chrysanthemums. Many growers have had their choicest flowers ruined by them.

Rats are fond of meats of all kinds and devour them wherever they can be found. The injury begins at the slaughtering establishment. Most slaughterhouses are infested with hordes of rats, which live on blood and offal and attack the meat whenever an opportunity offers. No meat of any kind is safe unless kept in rat-proof refrigerators. Rats get access to the meat in some of the lower class markets and sometimes destroy a considerable quantity in a single night. Pantries, larders and cellars, wherever meat or game is kept, are raided by rats at every opportunity, and the loss from this source is very great.

Rats gnaw into butter tubs, excavate and honeycomb fine cheeses, and consume and ruin more or less milk and cream. They drink and contaminate human beverages of many kinds if left uncovered, sometimes even gnawing into casks of wine or cider.

The complaints regarding the ravages of rats among poultry are pathetic. In some years 50 per cent. of all the chicks and ducklings hatched in certain neighborhoods are killed by rats, and occasionally a single poultryman loses hundreds of chicks by them. Rats often rob hens' nests as soon as the eggs are laid, carrying the eggs away without breaking them, so that a great part of the loss is never even suspected. Pigeons' eggs and young are just as readily taken as those of the larger fowls, as rats are very skillful in climbing for them. When it is considered that the annual product of eggs and poultry from the farms of the United States considerably exceeds $500,000,000 in value, it will be seen how serious a loss rats may cause to this industry, and to the middlemen and retailers as well.

Professor Lantz tells of a commission merchant in Washington, District of Columbia, who lost 71½ dozen eggs by rats from a tub in which 100 dozen had been nailed up.

The loss of young chicks and eggs is not the only poultry loss suffered by poultrymen and dealers. According to Dr. Bos, rats have been known to bite flesh from living fowls,[1] and

[1] Bos, J. R., Agricultural Zoölogy, 1894, p. 39.

some writers have asserted that rats can and do kill full-grown fowls.

Rodwell avers that in a short time he lost by rats all his rabbits, guinea pigs, pigeons, and a large "setting" hen and her complement of eggs, and he mentions other instances where full-grown fowls and ducks were believed to have been killed and partially eaten by rats.[1]

Dr. Brehm says that Las Casas tells us that on the night of June 26, 1816, the rats ate all the provisions in Napoleon's house on St. Helena leaving him and his companions breakfastless, for poultry keeping had been abandoned because rats ate the fowls, even stealing them from their roosts in the trees.[2] I have doubted that it was possible for rats to kill full-grown fowls, but recently have secured corroborative evidence from poultrymen. Mr. C. H. Bradley, superintendent of The Farm and Trade School at Thompson's Island, says that rats have gnawed the flesh from living turkeys at the farm, attacking them near the tail or eating out part of the breast. Some recovered, others died, and he has lost hens in the same way. Miss Florence E. Curtis writes from Whitman, Massachusetts, that rats kill her hens by eating off their heads at night, and Brewster and Dupuy assert that rats kill chickens, ducks, geese, partridges and the like, overcoming them, in spite of their size, by one deft bite through the neck.[3]

Mr. John B. King of Newburyport says that so long as rats can get a plentiful supply of grain they will not touch the poultry, but he says that his neighbor, Mr. Frank E. Silloway, who raises partridge cochins, has lost ten hens and one cock, averaging about eight pounds in weight, and that another neighbor has lost several brahmas in the same way. The rat usually gets the fowl by the head, and is thus enabled to hang on until the bird is dead, or it bites it through the neck (some old rats are very skillful at this); then the flesh on the head and neck is commonly devoured first, or the brains are eaten out. Mr. King says that at one time when he was breeding brown leghorns and keeping his grain in a rat-proof box, he frequently

[1] Rodwell, James, The Rat, 1858, pp. 74, 76.

[2] Brehm, Alfred Edmund, Life of Animals, 1896, p. 334.

[3] Dupuy, Wm. Atherton, and Brewster, Edwin Tenney, McClure's Magazine, May, 1910, Our Duel with the Rat, p. 69.

found the heads of some of his fowls mangled and bloody in the morning. Finally he found one dead, and one eye and the side of the face eaten off.

Mr. Bradford A. Scudder tells me that Mr. Henry W. Walker, a neighbor, told him that within the past six months more than a dozen of his hens had been killed or seriously injured by rats. The dropping board was close below the perch, and some of the hens were attacked in the abdomen. Others were killed apparently by a bite through the neck, and their brains were eaten out. He believes that this was the work of rats, as no other animal could have gotten at the chickens in that place.

In August, 1914, I visited the heath hen reservation maintained by the Massachusetts Commissioners on Fisheries and Game on Martha's Vineyard, and there saw the body of a young Canada goose, fully fledged, that, according to the statement of Mr. William Day, the deputy commissioner in charge, had been killed by rats in the night. The head had been eaten off and the neck stripped of flesh. Later, the rats ate out much of the carcass, as may be seen by the illustration. In this case as well as that of the hens and turkeys at Thompson's Island, the circumstances were such that apparently no other animal than the rat could have been responsible.

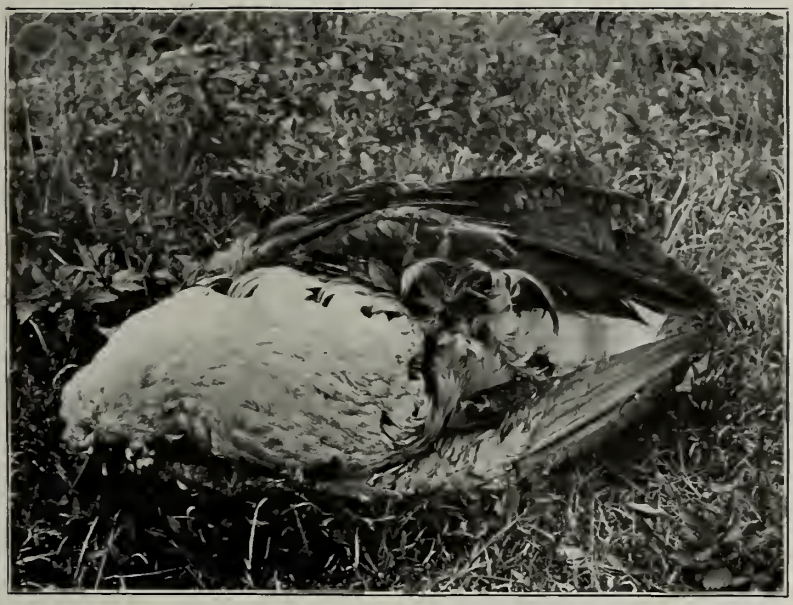
Rodwell says that rats found an entrance to an aviary containing 366 birds and killed 355 of them in one night.[1]

Rats are very destructive to wild birds. A very large percentage of the eggs of bullfinches, linnets, and other small birds are said to be eaten by them in England.[2] Mr. C. H. Bradley, superintendent of The Farm and Trade School on Thompson's Island, tells me that he and his family, hearing distressed cries from a robin's nest at twilight, saw a rat that had climbed to the nest and was eating the young birds. It is a well-known fact that rats destroy the eggs and young of ground-nesting birds. Rats sometimes exterminate colonies of sea birds. A few years ago a ship was wrecked on an island off the Maine coast, which was at that time the resort and breeding place of great numbers of terns. Rats that came ashore from the wreck multiplied exceedingly and destroyed or drove away all the sea birds

[1] Rodwell, James, The Rat, 1858, pp. 69, 70.

[2] The Spectator (London), Vol. 95, Oct. 21, 1905, p. 604.

PLATE I.



The carcass of a young Canada goose, fully fledged, killed and largely eaten by rats at the Heath Hen Reservation at Martha's Vineyard, maintained by the Massachusetts Commission on Fisheries and Game. The head had been gnawed off and the neck stripped of flesh. (Original photograph.)

breeding on the island. Many such instances have been noted on islands in various parts of the world. The rat often becomes the most serious pest of the game preserve and the zoölogical park; it destroys not only the food of birds and mammals, but the birds and their eggs and the young of mammals also. Many a gamekeeper finds rats more destructive to his young birds than hawks, owls, cats, foxes and all other so-called vermin put together.

Rat depredations are attributed often to other animals; the skunk, weasel and mink are commonly blamed when the rat is the culprit. The eggs and young of pheasants, bobwhites and ducks are its common prey. Rats sometimes kill and eat young pigs.

Dr. Brehm says that rats sometimes eat holes into the bodies of very fat swine, and that they eat the webs from between the toes of closely penned geese. Gilbert White asserts that rats ate away portions of the feet of an elephant in the London Zoölogical Gardens while the creature slept. The rats were destroyed and the elephant was put into a new house, where it recovered, but Brehm says that Hagenbeck, the dealer in animals, had three young African elephants killed by rats; the rats attacked the soles of their feet and gnawed through them.[1]

This seems almost incredible, and it is always questionable whether some of the birds and animals supposedly killed in the night were not dead or dying before they were molested by the rats. The boldness of rats, however, is well known. Craig says that they will gnaw the feet of sleeping dogs and nibble the hoofs of stabled horses.[2] This is corroborated by Kane, and recent instances of hoof gnawing are reported.

Rats confer some slight benefit on man by killing and eating rats, mice, some few insects, some carrion, offal and garbage and a great deal of sewage, but the benefits derived from rats are slight, indeed, compared with the injury that they do.

Rats damage property in many ways. They cause the decay of sills, floor timbers and floors by bringing up moist soil in contact with them, thus making conditions favorable for timber-destroying ants. They injure the timbers of buildings by

[1] Brehm, Alfred Edmund, Life of Animals, 1896, p. 334.
[2] Craig, Hugh, The Animal Kingdom, 1897, Vol. 2, p. 689.

gnawing them away in order to make passages into or through the walls. They sometimes even gnaw off the corners of hard bricks when such are in the way of their passage. They gnaw almost any building material except the very hardest brick, concrete, cement, glass and iron. They have been known to gnaw through zinc drain pipes and lead water and beer pipes, often causing flooding of buildings and great loss. They have compelled the manufacture of iron gas pipes, which formerly were made of softer material. There are indications that sometimes lead pipes are gnawed to secure water, but this cannot be the case with gas pipes, which are more likely to be severed when the rats attempt to enlarge the holes through which such pipes pass. They drill through flooring and plastering, un-

Miscellaneous damage.

dermine foundations and concrete floors, and ruin drains. They injure the planks and timbers of wooden ships, and although they are said never to gnaw through the planks so as to cause a leak, they have no doubt greatly weakened the fabric of many vessels, and perhaps have been responsible for the loss of some by water as well as by fire. They injure furniture, destroy mattresses, upholstery, matting and carpets; steal and hide in their holes jewelry and other valuable articles; destroy cloth, bagging, clothing, books, silk hosiery, silk handkerchiefs, towels, napkins and other dry goods, letters, skins of birds and mammals, felting, wills, deeds, drawings and other valuable papers; injure stored goods; eat labels off shoe boxes and other cartons, and injure packages of all kinds that are fastened with paste or glue. In a store in Washington, District of Columbia, they destroyed fifty dozen brooms worth $125. In another they broke $500 worth of fine china in a night, knocking it from the shelves. A restaurant lost $30 monthly in table linen, and a hotel $15

in linen in one month. They gnaw ivory, shoes, gloves, leather and rubber goods in stores; ruin harnesses; strip paper labels from canned goods, and even eat manufactured feather goods in the millinery stores. They destroy mail sacks and their contents. I talked with a clerk in a large clothing emporium who told me that the firm had employed a man regularly as a rat catcher for two years, but that rats were still so numerous that they ruined about one suit of clothes nightly.

Rats kill trees by undermining and gnawing their roots. They burrow into and undermine dams, dikes and levees, often causing breaks and serious losses. They cause much damage to all fish hatcheries and fish ponds where food fishes are artificially propagated, for there they gnaw through wooden tanks, burrow into the embankments and destroy quantities of fish which they catch and eat.

About the year 1616 rats caused a two years' famine in Bermuda. They were considered largely responsible for a famine in India following the year 1879, and became so numerous on the Island of Mauritius that the Dutch were compelled to abandon it.[1]

Rat Incendiarism.

Fires are attributed commonly to rats and matches. Rats are attracted by the phosphorus contained in matches, or by the paraffin in which some manufacturers of matches dip their goods. Matches have been found in rat nests, and in one case at least a nest was found which had been set fire by such a match which nearly caused a fire on Her Majesty's ship "Revenge."[2]

The incendiary.

Rats' winter nests are made commonly in buildings, between walls and near chimneys, where it is often very hot. The nests are built of dry and inflammable material. When rats take matches to these nests fire is very likely to result, either from the friction of the rats' teeth or from the heat, which readily ignites matches containing a large percentage of phosphorus.

[1] Lantz, David E., Treas. Dept., Public Health and Marine Hospital Serv. of U. S., The Rat and its Relation to the Public Health, by various authors, 1910, p. 223.

[2] Hardwicke's Science Gossip, Vol. 5, 1869, p. 142.

It is believed that a considerable proportion of the great loss of life and property by fire in the United States is due to rats alone, for the foregoing is not by any means the only way in which they set fires. Fires in mills have been traced to the spontaneous ignition of oily rags and cotton waste carried under floors by rats and mice. Gas explosions and resultant fires have been caused by rats eating away lead pipes leading to gas meters, and human lives have been put in jeopardy through the leaking of gas from this cause even when no fire resulted. Rats often gnaw away the insulation from electric wires, and in recent years this has become probably the most fruitful cause of city fires that can be attributed to rats. Insurance companies a few years ago estimated the fire loss in the United States due to defective insulation of wires at $15,000,000 yearly, a large part of which is directly due to the depredations of rats.[1] No doubt the annual loss from this source has increased rather than diminished.

The Cost of keeping Rats.

The cost of keeping rats has been variously computed. The annual upkeep per rat is estimated by the Incorporated Society for the Destruction of Vermin (British) at $1.80 in Great Britain, $1.20 in Denmark, and $1 in France.

Surgeon R. H. Creel of the United States Public Health Service estimates one-half cent a day ($1.82 a year) as a conservative figure of the cost of keeping a rat in the United States;[2] and this seems very reasonable as it barely exceeds the estimate for Great Britain. At this rate a farmer or stable keeper who keeps 50 rats loses $91 yearly, and he who maintains 100 rats loses $182 annually. It is a poor farm that cannot sustain 50 to 100 rats.

Professor Lantz says that the average quantity of grain consumed by a full-grown rat is fully two ounces a day, and that a half-grown rat eats nearly as much as an adult. If fed on grain, therefore, a rat eats 45 to 50 pounds a year, worth about 60 cents in wheat or $1.80 to $2 in oatmeal. If fed on modern "denatured" cereals in packages, such as are used in our

[1] Lantz, David E., U. S. Dept. Agri., Biol. Surv. Bull. 33, 1909, p. 28.
[2] Creel, Richard H., U. S. Public Health Reports, Vol. 28, No. 27, July 4, 1913, p. 1405.

households, the cost of maintaining a rat is greatly increased, and if fed on beefsteak, young chickens or squabs, the cost would be still greater. Hotel and restaurant keepers have estimated $5 as a conservative statement of the cost to them of keeping a rat a year. In addition to this, the injury that they do to property of other kinds is sometimes greater than that done to food supplies. Estimates of the amounts of losses from rats in foreign countries have been published. In Denmark they have been reported to amount to 15,000,000 francs, or $3,000,000 yearly. In France the total losses from rats and mice in 1904 were estimated at 200,000,000 francs, or nearly $40,000,000. The German Ministry of Agriculture states that through the agency of the rat the people of Germany suffer an annual loss of at least 200,000,000 marks or $50,000,000.

Sir James Crichton-Browne, of the English Incorporated Society for the Destruction of Vermin, asserts that the damage done by the rat to agriculture and rural communities alone in Great Britain and Ireland equals £15,000,000, or about $73,000,000 per annum. This takes no account of the injury done in towns or in connection with shipping.[1]

Professor Lantz estimates that the cities of the United States lose $35,000,000 annually from the depredations of rats. He says that if the number of rats supported by people of the United States were equal only to the number of domestic animals on the farms, the minimum cost of feeding them grain would be upwards of $100,000,000 a year. If we were to take the estimate of Surgeon Creel, that the depredations of a rat cost one-half cent each day, or $1.82 per year, and assume that there are only as many rats in the country as there are people (on the basis that the population of this country is now in round numbers 100,000,000), the rat would cost the people of the United States $182,000,000 a year. Any estimate of this kind must be largely guesswork, but a great indirect tax is not included in the above estimate, that is, the cost of the fight against the rat. No account can be had of the enormous sum paid for traps, poisons and rat catchers, the expense of fumigating steamships and rat-proofing buildings. The loss of rents is a serious item, as tenants are not infrequently driven out

[1] Lantz, David E., U. S. Dept. Agri., Biol. Surv. Bull. 33, 1909, p. 19.

when rats become so numerous as to disturb their sleep and destroy their property. Professor Lantz speaks of an entire block of houses which remained untenanted for months because they were rat infested, and the owners lost yearly $2,000 in rent. I have known cases where tenants have left homes for this reason. The keeping of rats in city or country is extremely expensive from all points of view.

All the above indictment of the rat refers only to the property that it destroys, and does not take into consideration its effect on the public health. It remains now to consider how it menaces not only man's property, but his health and his very life.

THE RAT MENACE TO HUMAN LIFE AND THE PUBLIC HEALTH.

Many accounts have been published of rats attacking human beings. A great number of such tales might be collected, but it would serve no good purpose. The old story of Bishop Hatto, who shut himself up in a stone tower to avoid the swarming rats that later found an entrance and devoured him, is perhaps one of the earliest of these tales.

There are many narratives in print regarding the death of elderly, infirm or intoxicated persons, and prisoners in dungeons, who were supposed to have been killed and partially devoured by rats; also tales of sleepers, especially infants, attacked by them and seriously injured or killed. Naturalists add to these tales. Buffon says that dying persons, prisoners and children in the cradle have been gnawed by rats. Waterton tells of a woman who was bitten on the shoulder while asleep. Jardine speaks of brown rats attacking people and mutilating infants. Buckland tells of a man attacked by rats, an infant killed by them, and the corpse of a pauper terribly mutilated by them in the morgue. Rodwell tells of children in the cradle having fingers eaten, toes, faces and necks lacerated, etc., some of whom died, apparently from the effects of such mutilation or from infection.[1] Newspaper reporters make the most of any occurrence of this nature, though usually it may have little foundation in fact. While it is true that rats will

[1] Rodwell, James, The Rat, 1858, pp. 52–57.

fight savagely when cornered, and may inflict infectious wounds, as I know from personal experience, the cases where they make unprovoked attacks on human beings are rare. Under some circumstances a swarm of hungry rats might attack a man in the dark, but probably most of the narratives of such occurrences are much overdrawn. Nevertheless, it is true that sleepers, particularly infants, have been bitten, and in some cases such attacks may have resulted fatally from infection carried on the teeth of the rat. This constitutes a real though rather remote danger which should be guarded against.

I have investigated the cases of three persons, now living, who have been bitten by rats while asleep, — one while an infant, the other two in youth. The chairman of a city board of health still bears scars on his forehead, the result of such an attack, but the most recent fatal occurrence of this kind that has come to my notice is that of a newly born infant. This child was born to Mrs. Frank W. Silver of 57 Clovelly Street, Lynn, at a hospital, on the morning of September 5, 1914. During the next night the nurse left for a time the room in which the baby lay, heard the child cry and hurrying back saw a rat jump from the bed. The infant's head was bleeding and it died at about 3 A.M. September 8. One of the Boston papers contained a long account of the occurrence, in which it asserted that District Attorney Henry C. Attwill had ordered an autopsy to determine the cause of death.

A few days later an item appeared, part of which follows: —

> Lynn, September 11. — That the death at a hospital Tuesday of the two-day-old infant of Mr. and Mrs. Frank W. Silver of 57 Clovelly Street was due to the bite of a rat was the conclusion reached to-day by Medical Examiner Magrath of Boston, who made a pathological examination of the organs of the infant. After hearing from Dr. Magrath, Medical Examiner O'Shea signed the death certificate, and attributed the death to poisoning, resulting from the rat bite.

The only error in this item seems to be the statement that the child was but two days old. It was nearly three days old.

In order to determine whether the newspaper reports were warranted by facts, I wrote to Dr. O'Shea, who kindly sent me a statement of the findings of the medical examiner at the

autopsy, which showed that the child's skull had been penetrated by the rat's teeth, which had not, however, reached the brain. The internal organs examined were infected. The anatomical diagnosis was "streptococcus septicæmia." Dr. O'Shea says: —

From the fact that the autopsy and microscopical and bacteriological examinations revealed nothing other than the presence of streptococcus sepsis to which the child's death could be attributed, together with the absolute knowledge of the rat bite, it seems reasonable to give the latter as the primary cause of death in this case.

In reply to another letter, Dr. George Burgess Magrath, medical examiner, northern district, Suffolk County, who performed the autopsy, writes as follows: —

In reply to your letter of September 25 I beg to state that the child in question died from streptococcus septicæmia about two and a half days subsequently to infection of the scalp, presumably and evidently caused by rat bite. Although the incidence of the septicæmia was quite rapid, I have no doubt that it was in consequence of the injury specified.

The term "rat poisoning," which you use, I am not familiar with; I assume it to be co-ordinate with septicæmia.

This occurrence should warn all hospital authorities to keep their premises clear of rats. I happen to know that at least one hospital is infested, and there may be others.

On the other hand, the unreasonable fear of rats exhibited by many people is ridiculous. Some women go into hysterics at the sight of a rat, and there are tales of people made temporarily insane by contact with the creatures. The bite of the rat is not always and perhaps not often infectious. In my own case it was followed by inflammation, suppuration and pain, which lasted many days, after which there was no further inconvenience.

Dr. Horder, of St. Bartholomew's Hospital, London, reported three cases of a disease, previously undescribed, which he called rat-bite fever. Having been bitten by a rat, each patient, after an incubation period of three or four weeks, suffered inflammation of the lymph channels in the tissues about the bite, accompanied by malaise, anorexia and fever. Hard, reddened patches appeared distributed over the skin, and tender swellings

of the muscles. The attack lasted a few days or a week, and was followed by similar attacks at intervals of from three to ten days. These intermittent symptoms in some cases extended through several months.[1]

The most serious indictment against the rat is the destruction of human lives caused by it as a carrier of diseases fatal to mankind. The deadly bubonic plague is communicated to man mainly by the rat flea. The infection is conveyed from rat to rat, and from rat to man solely by the rat flea. The conclusions of the India Plague Commission have proved this. There is some reason to believe that certain Asiatic marmots carry the bacillus and some Asiatic and American squirrels have been infected, but the chief distributing agent is the rat. Professor Lantz states that within a dozen years there were 5,000,000 deaths from the plague in India, and in 1897 the plague destroyed 1,200,000 natives of that country. By the year 1908, the present pandemic of the disease, which started in China in 1894, had invaded every continent and secured a foothold in 51 countries. Already (1914) it has reached the United States in Hawaii, San Francisco, Seattle, Porto Rico and New Orleans. With the increase in traffic at the port of Boston, there is constant danger that it may be brought here by ship-borne rats. Probably no seaport is now safe from this pestilence, and the only known method of combating it is to isolate all patients and to extirpate rats. In the campaigns against the rat, buildings have been razed and burned, and all ships in infected ports have been fumigated to destroy rats, and many people have been engaged in hunting, trapping and poisoning them.

Germs.

Ptomaines.

This infection does not persist in the soil and a case of bubonic plague in man is not in itself infectious. The nonepidemic season is bridged over mainly by acute plague in the rat. Where there are no rats there are no rat fleas, and, therefore, there is no plague.[2]

Trichinosis among swine, a dreaded disease fatal to human life, is disseminated mainly by the rat. Trichinæ are minute

[1] Treadwell, A. L., The New International Year Book, 1910, p. 622.

[2] Lantz, David E., U. S. Dept. Agri., Biol. Surv. Bull. 33, 1909, p. 31.

internal parasites, and the only two farm animals known to be infested by them are the hog and the rat. The disease in hogs is caused by eating trichinous rats or trichinous pork. Country slaughterhouses, where rats are abundant, are among the chief sources of trichinous pork, which if not thoroughly cooked, communicates the disease to the person who eats it. Rats are subject to many intestinal worms and other internal parasites, and also to a kind of leprosy. Fatal so-called "septic pneumonia" is said to result sometimes from drinking water from wells where rats have been drowned.[1]

Rats are disseminators of the germs of many diseases, because of their habits of frequenting privies, drains and sewers for the food they find there. Ptomaines are likely to be conveyed to human food in this manner. Rats are numerous in slums and hovels where malignant and loathsome diseases flourish, and so undoubtedly they convey infections to other localities by contact with food or food receptacles. Medical men and municipal boards of health are beginning to take cognizance of the rat as a dangerous agent in the dissemination of common diseases of both children and adults, but to what extent, if any, this animal distributes the seeds of typhoid and scarlet fevers, diphtheria and other malignant diseases, remains for future study to determine.

CIRCUMSTANCES FAVORABLE TO THE MULTIPLICATION OF RATS AND THEIR APPEARANCE IN LARGE NUMBERS.

Rats can increase rapidly in numbers only under the most favorable conditions. As hereinbefore stated, a sudden influx of rats may usually be accounted for by a sudden scarcity of food somewhere, followed by migration. Rats naturally turn first to vegetable food, such as nuts and seeds. Certain seeds seem to be preferred by most rats to all other food, and wherever such nourishment is plentiful, rats multiply rapidly. Plagues of rats occur in Brazil after the bamboo blooms. This great plant matures, produces its seed and dies, at intervals of several years, and according to Mr. Herbert H. Mercer the

[1] The Spectator (London), Vol. 95, Oct. 21, 1895, p. 604.

species most abundant in Brazil lives about thirty years. The seeding is not simultaneous with all plants, but lasts about five years, more and more canes seeding each year, and each cane producing an astonishing amount of fruit, so that often the ground is covered inches deep with the fallen seed.

In 1879 Mr. Orville A. Derby found an almost universal lack of corn throughout the Province of Parana, Brazil, which was due to an invasion of rats which followed the fruiting of the canes. Each cane bears about a peck of edible seed, resembling rice, which is very nourishing. During the fruiting season the number of canes bearing seed increases each year, and the rats multiply accordingly. The last of the crop of seeds having matured and fallen to the ground, decays. The rats, suddenly deprived of food, begin to migrate and invade the plantation houses, consuming and destroying everything eatable. At corn-planting time the seed is eaten as fast as it can be put into the ground. Mr. Mercer replanted six times in one year, and finally gave up in despair. The rice crop is ruined, and everything in the houses in the way of provisions and leather is destroyed if not carefully guarded in rat-proof receptacles.[1] Similar plagues of rats occur in Chili, where the cane fruits in the same manner;[2] also in Ceylon, following the flowering and death of tropical underwoods, which fruit in the same way as the cane, but about every seven years. The rats afterward attack coffee plantations and prove very destructive.[3]

Grain growing offers a similar attractive food supply for rats. They can live in the fields in summer and fall, storing up a certain supply of food in their burrows for winter. In open or southern winters they can pick up much waste grain. In the north, their sudden appearance in large numbers in November or December may be due to the approach of winter, which drives many into farm buildings or into villages and cities. Farms with accumulations of rubbish under, in and about the buildings harbor rats by the hundred in winter, and hay and grain stored in the barns too often furnish them such a liberal supply of food that they may breed in any month of the year. A sudden local appearance of rats in numbers often is due to energetic measures taken by some neighbor to rid his premises

[1] Nature, Vol. 20, May 15, 1879, p. 65.
[2] *Ibid.*, Vol. 20, Oct. 2, 1879, p. 530.
[3] *Ibid.*, Vol. 20, July 17, 1879, p. 266.

of rats. He who has large numbers on his premises must recognize the fact that the rats are there because either he or his neighbors feed and protect them. If rats come to you in preference to your neighbor it is because you feed them more and treat them better than he does.

RAT RIDDANCE.

There is no royal, easy and immediate road to rat riddance. It requires continuous mental and physical exertion to banish the rat, but it can be done, and a reasonable expenditure to that end is a wise economy. Extermination is too much to hope for, and banishment from large areas cannot be expected without great co-operative effort, but the individual can clear his premises of rats provided the conditions are first made right. The means for ridding premises of rats may be outlined as follows: —

(1) Rat eviction: (*a*) destroying rat habitations and harboring places; (*b*) rat-proofing buildings.

(2) Rat starvation: (*a*) disposal of edible garbage and refuse; (*b*) rat-proofing receptacles for all sorts of edible materials.

(3) Rat slaughter: (*a*) traps; (*b*) poisons, chemical and biological; (*c*) shooting, clubbing, drowning, etc.; (*d*) encouraging natural enemies — owls, dogs, ferrets, cats, etc.

(4) Rat driving and harrying.

(5) Preventing rat multiplication: (*a*) all the above.

Not all of these methods are necessary in every case, but all are useful under certain circumstances. Methods of permanent eviction come first, as it is of little use to extirpate rats and then invite others to come in by continuing favorable conditions, such as a plentiful, accessible supply of food and numerous excellent breeding places.

Rat Eviction.

Those who deprive rats of nesting places, food and drink will evict them, for this prevents breeding, and rats will not stay long where they cannot eat and drink.

PLATE II.

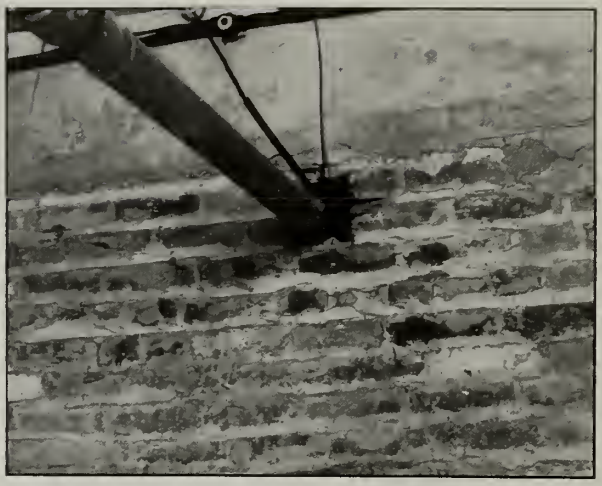


FIG. 1.— DEFECTIVE AND BROKEN WALL.

Entrance made for water pipes; should be repaired with cement the full depth of the wall. (From Public Health Reports, April 11, 1913.)

FIG. 2.— DEFECTIVE BASEMENT WALL (OPENING MADE FOR THE INSTALLATION OF HOUSE SEWAGE SYSTEM).

Opening left around sewer pipe and not subsequently closed. A convenient entrance for rats; should be closed with cement. (From Public Health Reports, April 11, 1913.)

Destroying Rat Habitations and Harboring Places.

Outdoor rubbish and woodpiles give rats the best possible protection by hiding and covering the entrances to their burrows or nests, so that nothing larger than a rat can get at them. Any hole in which quantities of tin cans and rubbish have been dumped is almost sure to be frequented by rats. Public dumps and the neighborhood of such places are certain to be infested by them. A general clearing up, which is sanitary and commendable for many reasons, is a necessary preparation for a rat campaign. Rubbish, garbage, etc., should be burned. Wood should not be piled on the ground in or near buildings. All rat holes in cellar or foundation walls should be treated with unslaked lime or chloride of lime and then stopped with a mixture of cement, sand and broken glass, in which glass predominates.

Rat-proofing Buildings.

Improved building construction is most important; it is expensive, but will pay in the end by doing away with most of the annual loss due to the depredations of rats in buildings.

A grocer in a Massachusetts town complained to his landlord of the injury to his stock caused by rats, and asked to have the building rat-proofed. The landlord replied that he could not afford it, but would pay the cost of the stock destroyed by rats in the store each month. At the end of the first month the grocer presented a bill for $25. The landlord made some forcible remarks and doubted the loss. He was shown the ruined goods, and decided that it would pay to rat-proof the building. When this had been done the rats remaining in the building were destroyed by phosphorus, and the grocer has had little trouble from rats for years.

Stone or brick walls as underpinning will shut out rats if all crevices can be stopped with good cement mortar, but concrete or reinforced concrete is the best material for rat-proof construction. City ordinances everywhere should require such construction in the cellars and foundations of all dwelling houses and business blocks, and tenants should everywhere demand it as a protection against disease and the destruction of property. When buildings are under construction the addi-

tional cost of rat-proofing is slight indeed in comparison with the advantage gained. Cellar walls, if made of stone, should be laid in concrete, and the cellar or basement floor should be of medium concrete 3 inches thick overlaid with cement. Such floors will be better drained and will not be undermined by rats if 8 or 10 inches of gravel can be put in as a foundation and the concrete laid upon it. If, then, the walls on which the sills of the house rest are of brick, stone or concrete, rising 2 feet or more above the ground, and the doors, windows and other openings are well protected, there will be little chance for rats to gain access to the building. A rat must have some shelter and something to stand on to gnaw through the wooden wall of a house. A veranda sometimes offers such an opportunity, as the rats may find some support beneath it from which they may penetrate the wall. Verandas and walks should be made of concrete or similar material laid on gravel, with side walls extending at least $2\frac{1}{2}$ feet under ground. Plank walks furnish excellent accommodations for rats and should be done away with. As an additional safeguard the walls of the house above the sills may be filled with cement up to about 2 feet above the floor. This will prevent rats burrowing into the wall. If upper windows are left open, and unscreened, rats may enter them by way of trees near the house or vines climbing upon it. If rats gnaw the doors all outer doors should be provided with metal strips 6 inches wide at the bottom, and each outer door or screen door should have a spring or check device to keep it closed. Cellar windows, skylights and ventilators should be screened with galvanized wire netting of half-inch mesh and not less than 20 gauge. Any unused chimney should have all openings closed with tight-fitting covers and the top screened. Traps that rats cannot crawl through should be used in all water-closets; otherwise they may enter the house from the sewer. All holes where pipes pass through cellar walls should be closed with concrete. In large storehouses or warehouses, particularly those without cellars, it is a great advantage to make the lower floor of reinforced concrete. In stores or dwelling houses where this cannot be used solid concrete walls and a double floor with $1\frac{1}{2}$-inch mesh wire netting of not less than 20 gauge nailed

PLATE III.

FIG. 1. — UNSCREENED BASEMENT VENTILATOR.

Rats enter basements from the street through such openings. They should be covered with wire-mesh screen. (From Public Health Reports, April 11, 1913.)

FIG. 2. — RAT SCREENS.

Properly screened basement ventilators under show windows. (From Public Health Reports, April 11, 1913.)

between the floors and extending up 8 inches under mopboards and casings will suffice.

Nothing harbors rats in town or country like the barn, shed or other building with timbers laid on the ground or near it, with just space underneath to accommodate rats and exclude dogs and cats. Small ricks or buildings, such as corn barns, henhouses, woodsheds, etc., may be made rat-proof by setting them up on posts at least 2 feet from the ground (3 feet is better), provided there are no lumber or rubbish piles, trees, chicken ways, etc., by which rats may gain access to the building. Dogs, cats, skunks, weasels and other natural enemies of rats can pass freely beneath such buildings, and will make life unpleasant for the rodents there. There should be no projection of post or beam to which the rat can climb and on which he can stand and gnaw through the floor above.[1] The New England corn barn, standing on four high posts, capped by inverted milk pans and reached only by a ladder, is effective, but its usefulness is too often minimized by lumber, rubbish or other material lying or leaning against it, and forming a bridge or ladder on which rats may enter. A building lined with wire netting of one-half inch mesh and 20 gauge, such as is used for screening cellar windows, is thus protected against rats, mice, squirrels or birds. Henhouses and brooder houses usually are built on the ground, or on posts set into it, with board or dirt floors. Some poultrymen use inch mesh chicken wire netting to keep out rats, digging a trench $2\frac{1}{2}$ feet deep around the building, and burying the wire netting upright in this, having first attached the upper end to the sills. I have used this wire with good results, but only when the small doors leading out into the yards were at least 24 inches from the ground, and when the fowls were not furnished gang-planks to walk out on, but were obliged to fly up to the entrances. Mice and small rats, however, will readily pass through this netting, and half-inch mesh is better. In rare instances rats dig under such a 30-inch netting and it should extend 36 inches under ground. The plan used on some game preserves may be better for pens. About a foot of netting is laid on the ground, extending out, not in, from the base of a wire fence or building. It is said that all

[1] Poultry houses thus raised are free from dampness, but expert poultrymen do not recommend them for winter use in New England.

predatory animals try to burrow close to the wall or fence, and finding the wire desist. Concrete foundations and floors combined with the use of fine mesh netting to cover all openings may be recommended as the surest way of rat-proofing poultry houses. A foundation wall should first be provided, extending at least 1 foot under ground (3 feet would be better) and 1 foot above it. If the wall is slightly wider at the bottom than at the surface it will better withstand the heaving of frost. At least 8 inches of gravel may be laid on the ground under the floors inside the walls to insure good drainage. If the sills of the building are then laid on the walls, rats cannot reach the sills to gnaw through, and they cannot burrow under the floor and undermine it.

A poultryman recently concreted the floor of his henhouse, but allowed the sills to rest on the ground. Immediately rats gnawed through the heavy spruce sill and tunneled under the concrete, working through it before it had hardened, entering as freely as before.

Dr. R. H. Creel says that chicken pens can be protected by concrete walls extending down 2 feet or more into the ground with half-inch mesh wire netting covering the sides and tops of the pens. This will prevent rats, mice and sparrows from getting in and will protect chickens against cats, hawks and other enemies. Fowls should be fed always in rat-proof houses, sheds or pens, never in open yards. In this way the great loss which ordinarily occurs in feeding rats, mice and English sparrows will be avoided. Open-front henhouses or scratching sheds should be covered with half-inch wire netting in order to keep rats from climbing in through the wire. Pigeon lofts should be similarly protected. No opening must be left anywhere unguarded. A gentleman in Milton, Massachusetts, found it impossible to raise squabs on account of the depredations of rats, which, notwithstanding he had wired his pigeon loft, continued to kill pigeons and squabs, although the only opening was a window about 20 feet from the ground. It was suggested that he put a wide sheet of zinc around the window. This proved effective, stopping the entrance of both rats and squirrels, as they could not climb up or over it. It is difficult to keep rats out of barns and stables where doors are constantly left open, but something may be done.

RAT-PROOF HENHOUSES OF HERBERT THAYER, HARVARD, MASSACHUSETTS.

This shows raised form of construction. Rats have never troubled these henhouses, but they would be better if raised higher from the ground and if the boxes, ladder, etc., which might give access to the rats were removed. These henhouses were not raised by the owner for the purpose of rendering them rat-proof, but to keep the hens off the damp ground. (Photograph by E. I. Farrington.)

PLATE V.

RAT-PROOF SHED.

Concrete foundation extending two feet into the ground and one foot above floor level. Concrete floor, roof covered with corrugated iron.
(From a photograph by Dr. William Colby Rucker of the United States Public Health and Marine Hospital Service.)

Concrete barn cellars will help to prevent rats from harboring in barns. Horse manure might be kept in a concrete pit with a cellar wire screen or a close cover over the top. Cow manure will not interest rats unless grain, straw or some similar food is mixed with it. All wells, water tanks, etc., should be rat-proofed, for rats must have water.

Rat Starvation.

Separating rats from their food will drive them away if no other method is resorted to. Where food is plentiful and easily obtained it is difficult to trap or poison rats. Starvation, then, increases the effectiveness of trapping and poisoning.

Disposal of Edible Garbage and Refuse.

All garbage should be placed in covered rat-proof cans and kept covered. It should be burned or disposed of where rats cannot get it. If manufacturing concerns and business houses allow their employees to lunch in the buildings, all remains of lunches should be carefully disposed of. When thrown into waste baskets, on floors or even outside the building, such crumbs and pieces will feed many rats and mice daily, and perhaps neutralize well-directed attempts to rid the premises of the vermin.

Rat-proofing Food Receptacles.

All rooms in which food is kept should be rat-proofed with concrete, sheet metal or cellar wire netting, or all food should be kept in receptacles made of or lined with these or similar materials.

If horse mangers were built 18 to 24 inches deep, to prevent horses from wasting and scattering grain, and were set at least 2 feet away from the walls and entirely unconnected with them, a favorite food supply of the rat would be cut off. The ordinary shallow manger built against the wall seems designed for the express purpose of feeding rats and wasting grain. Hog troughs should be deep. Care should be taken not to spill and scatter grain in feeding.

Closely covered concrete vaults will keep rats out of privies.

If the rules above given were followed universally, rats would

be noticeable only for their scarcity, and the rest of this bulletin would be useful only to farmers who have rats in their barns and fields.

Rat Slaughter.

However thorough we may be in evicting and starving rats there always will be careless or indolent neighbors who will furnish them food and good breeding places, and so perpetuate and increase the species that we shall have to take care of the overflow. Occasionally rats will get into a rat-proof building through a door or window carelessly left open, and most farmers have rats in their barns or outbuildings recurrently, or constantly. Hence the necessity for continuous rat persecution and destruction. A little rat catching now and then has no appreciable effect. Rat slaughter is the only term that describes effective work.

For centuries the rat has been under the ban. Every expedient and contrivance that the inventive genius of man could devise for rat destruction has been utilized. It is not probable, therefore, that any new methods will be found in this bulletin, and if those here recommended have any merit, it will be because of precise detailed directions based on practical experience.

Rat Trapping.

Effective traps rate high among the means of destroying rats, and if used persistently and with judgment, in connection with a proper safeguarding of food supplies, many a home or farm may be cleared of rats by traps alone. An early experience convinced me of this. As a boy of fifteen, while attending a country seminary, I lived one winter with my aged grandparents on a small Massachusetts farm. They kept two overgrown cats, which never caught a rat, and the house so swarmed with the rodents that they sometimes disturbed our slumber by running over our faces, and even ate a hole in my bed. Henhouse, pigpen, woodshed, stable and barn all had their quota of rats, both black and brown, for at that time the black rat was still common in Massachusetts. An attempt to catch a rat in a steel trap resulted in the capture of one of the cats, so the cats were killed and a trapping campaign com-

menced. Having to attend to my studies, saw and split the winter's wood, do the chores in house and barn, and some cooking, churning, etc., I might have been considered fairly busy for a boy of fifteen, as boys go nowadays, but the rat catching devolved upon me and was my only pastime. There was but one trap, a rusty steel concern, used for woodchucks, but numbers of deadfalls and other contrivances, including mouse traps, were fashioned by candlelight and firelight, and from cellar to garret and from pigpen to haymow the number of destructive contraptions grew apace.

Pantry and grain bin were closed securely to starve out the rats and drive them to the traps, where a variety of bait was offered, but they still found some food about the barn, pigpen and henhouse. Soon, nevertheless, we were awakened at night, not by rats running over our faces, but by the bang of deadfalls loaded with bricks as the unsuspecting victims were crushed beneath them. At the end of the second month neither rat nor mouse, nor a sign of either, could be found about the house or any of the farm buildings. Thus I learned by observation and experience that it was possible to rid the farm of rats by traps alone, by taking a little time every evening for trapping. Patient, persistent trapping succeeded where cats had failed utterly, and no particular pains were taken to disguise or conceal the traps.

It is not always so easy to trap the rats on a farm as it was in this case, and some city rats are not so unsophisticated as were their country cousins in those days, but with conditions made right, traps may be used with great success.

The ingenuity of man having been exercised for many years in inventing rat traps, numerous designs have been perfected, most of which are effective, — if the rats can be enticed into them. "There is the rub." Box traps open at one end or both ends, figure 4 traps, and many others of the deadfall type, steel traps and gins, tin box traps, wire cage traps, traps with pitfalls and trap doors, traps with mirrors to entice the foolish rat to his downfall, traps for drowning, guillotining, hanging and electrocuting rats, torture traps, humane traps and many others have been put on the market, but success depends more upon the trapper than upon the trap. One man

will set a trap, keep it set for weeks, and catch nothing; another will take the same trap, and by handling and setting it in a skillful manner make a catch the first or second night. There are three types of trap easily obtained, all of which are successful if properly handled, and although I have tried many others experimentally, it never has been necessary to use more than these to clean out the rats, provided conditions have been first made favorable for their use. Often in such a case one style of trap will suffice.

Some rats may be taken by traps where food is plentiful and easily accessible, but trapping will be much more effective if they are deprived of all other food than that offered in or about the traps. Dr. Creel mentions a case where an experienced trapper set traps in and around a bakery for two weeks, changing his bait from time to time, but each morning his traps were ratless. Cheese, bacon, meat, vegetables, flour, nuts and other attractive baits were used unavailingly; but later, when the baker moved out and the rats had eaten all the loose flour and food remaining, more than 30 rats were trapped in a morning and in four days 80 were taken. "Traps or poisons," Dr. Creel says, "placed in the neighborhood of an overflowing garbage pail, in a pantry with open bins and exposed food, or in groceries and warehouses having foodstuffs spilled over the floor, will only result in wasted endeavor."[1]

In a general way this is true; still, I have taken rats by both traps and poisons in a large barn where grain bins were open and where grain lay half an inch deep under the straw on the floors of the lofts, and have seen eight rats caught, one each night for eight nights, in a single trap set in a grocery where they could easily obtain a variety of food, but it would be very difficult, if not impossible, to clear premises of rats under such conditions. Where rats are very suspicious one of the first requisites in successful trapping is first to treat them well for a time and feed them well, so that they will feel at home and become confident and careless; then set many traps, taking away all other food than that in or near the traps. Rat-hunting dogs and cats are a detriment to the trapper, as they frighten the rats so that they become cautious and suspicious.

[1] Creel, Richard H., Public Health Reports, Vol. 28, No. 27, July 4, 1913, pp. 1407, 1408.

Also, dogs or cats are likely to get into traps and carry them off, or to carry off captive rats, traps and all or to steal the bait. Hence, it is best to use traps only in buildings, boxes or other receptacles where dogs, cats and chickens can be shut out. In outdoor trapping, wild birds may be caught, unless the traps are concealed in boxes, holes or trenches. When dogs and cats and food other than that in the traps have been disposed of, trapping may be undertaken with a certainty of success.

Snap Traps. — The time-honored snap trap, which has been used by fur trappers for generations, is the steel trap. This is a good rat trap if properly set and concealed, but it is a cruel and inhuman machine unless used in such a manner as to kill the victim at once. As ordinarily set, without any precaution, it may now and then get a rat, particularly in grocery or provision stores, where food supplies are handled much. If a number of traps are kept constantly set so as to spring at a very light touch, and placed in rat runways or next the walls behind barrels or packing cases, a rat may now and then blunder into one, even if it is not baited. Sometimes unbaited traps are most successful, especially when the rats have become suspicious of baited traps. Rats may in time become so heedless of unbaited traps as to get caught, for the trap is far more patient than the rat; it can always afford to wait, and the rat is often necessarily in a hurry.

He who does not care to go to the trouble of covering or disguising his traps may succeed by first setting a number, baited, with the jaws open and the springs bound down by fine wire so that the traps cannot snap. The bait — bacon or strong toasted cheese — may be hung over the pan or tied to it. Fine sand or meal may be kept strewn about the traps for several days, and when the bait is taken nightly, and tracks in the meal or sand show that the rats have learned to run over the traps freely, the wire may be removed and the traps carefully set and baited. Some success has followed hanging the bait over the pan, but it is a cruel expedient as the rat is commonly caught alive by one leg.

No trap is more effective than the "break-back" or guillotine trap, provided with a wire fall, driven by a coiled wire spring

and sprung by a trigger, baited or unbaited, as seems best under different circumstances. (See Plates VI. and VII.) These traps are as humane as any, for (if set with circumspection) they usually catch the rat by the head, neck or back, killing it immediately. Occasionally, however, a rat will be caught by the leg, and will go off with the trap. For this reason all snap traps when set should be fastened to some heavy object or to the building by wire or cord. Sometimes the trap will be found sprung, but ratless. In such a case a mouse may be the culprit, and the trap, being too large for mice, springs over and past it. Sometimes the rat, coming in from the back of the trap, is missed or thrown off by the spring, and other times he is hit on the head by the trap but not held, and may be found dead not far away. A rat catcher explains this by the assertion that certain "wise old rats" reach in from the front or side and spring the trap by a quick side cuff, getting away as the trap springs, and that occasionally one is not quick enough and is caught by the fore paw or hit on the head. I am inclined to doubt this explanation.

Probably the metal trap (Plate VII., Fig. 2) is best, as it is durable and will not absorb and retain odors so readily as will the wooden traps. This trap and the similar wood and wire trap (Plate VI., Fig. 2, lower left) may best be set in a very dark place or corner, behind some box or chest, as it is impracticable to conceal it. The wooden-backed trap is effective, as the rat cannot enter it from the back and so avoid the wire. If either of these upright traps is set with the back too close to the wall the wire release will strike the wall when the trap springs, throwing the trap forward, but it usually gets the rat.

The flat trap (Plate VI., Fig. 2, upper figures), which can be obtained for ten cents at the five and ten cent stores, is not quite so strongly made as the others, and occasionally a large rat will get out of it, but it may be relied upon to clear a house or store of rats if sufficient numbers are properly baited, set and concealed, and if the rats are deprived of food other than that furnished them at the traps. This trap may be easily disguised and hidden, but it has the disadvantage that the rat may come and get the bait from the back, and may thus escape the blow of the trap either by crawling

PLATE VI.

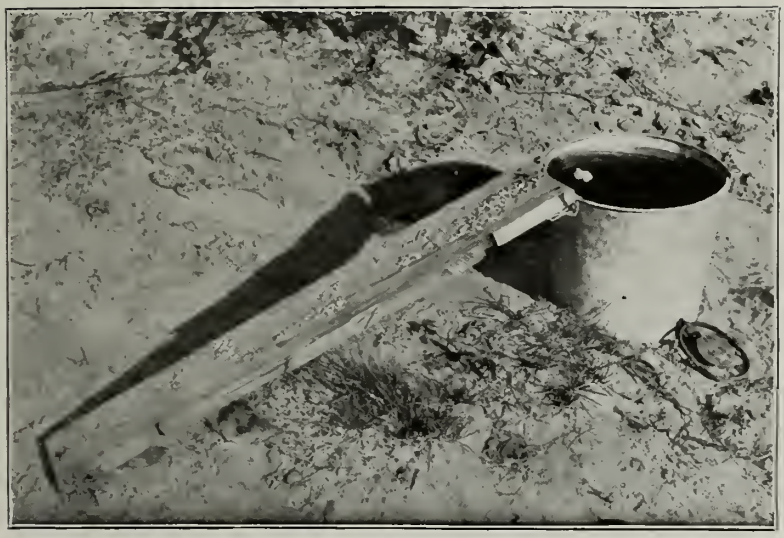


FIG. 1.— Trap set under water to deceive the experienced rat. This can be used most successfully in dark closets, attics or cellars. See page 47. (Original photograph.)

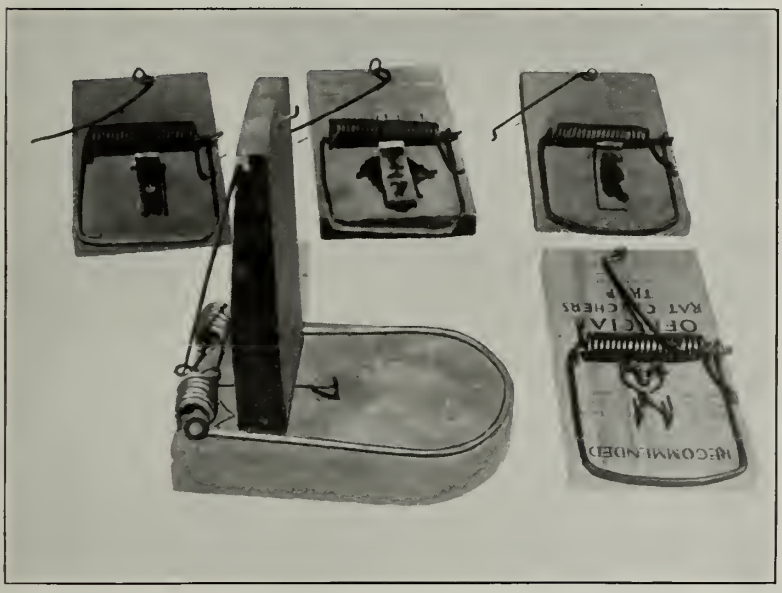
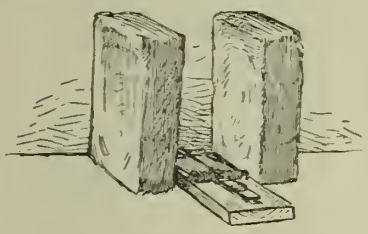
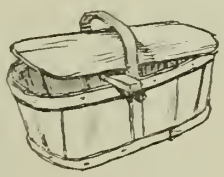


FIG. 2.— Different makes of the snap trap, all of which are effective, but the official trap — lower right — probably is best. (Original photograph.)

beneath the wire as he enters (I have seen a small rat do this), by crouching within the sweep of the wire so that it passes over without touching him or by being thrown off by the wire as it rises. Occasionally a rat will be found trapped that has been thrown in this way but carried clear over and caught on its back with its feet in the air. If the trap is set against a wall, with some obstruction like a brick set on either side, so that the rat cannot pass between the bricks and the wall, it is likely to run around to the front of the trap and so entering be caught (see cut); or the trap may be set so that it leans diagonally against the wall between two upright bricks in some dark corner, or even hung upon the wall an inch or two from the floor. It is not practicable to conceal it if hung up, but if so hung in some dark closet it may now and then get a rat. Another plan is to enclose the trap in a box with a hole placed so that the rat going in will come on the trap from the front, or the trap may be set in a covered grape basket, giving the rat room to enter only at the front under the raised cover. (See cut.)



Trap arranged for front entrance. The trap should be covered with chaff.



Grape basket with trap concealed inside.

The flat trap, different makes of which are shown on Plate VI., has been used mainly in the trapping experiments undertaken by the State Board of Agriculture, chiefly because it is inexpensive. One reason why many people have little success in trapping is *that they do not use traps enough.* Where rats are numerous 25 to 50 traps should be set, so that a considerable number of rats may be caught *at first,* before the alarm has spread. Every ten-cent trap that catches a rat saves the owner many times its cost. Rarely a single trap, carefully set, may catch a rat every night for a short time, but where rats are numerous they soon take the alarm, and one trap will not get enough in the end to keep pace with their increase.

A similar trap is the "official" (Plate VI., Fig. 2, lower right),

used by the United States government in its rat extermination work. This costs more than the other flat traps, but the advantage is claimed for it that the rat can spring it by either raising or lowering the trigger; also it has less wood in its construction than the other, which better fits it for outdoor use, and is more strongly made.

Exposure to rain and snow eventually will spoil any trap of this type, as rust will weaken the springs, while wetting and drying may cause the wood to split, but the official trap will stand a season's exposure to the elements.

Cleaning, Disguising, Scenting and Concealing Traps. — It is well known that trappers use scented baits to lure animals to their traps, and there is many a "secret" of the professional trapper that is supposed to insure success. Some of these lures are useful, among them strong-smelling foods the odor of which readily can be perceived from a distance by all wild animals.

Certain other scents, like musk, anise and catnip, are known to attract certain animals. In the days when rat-baiting was a common pastime, and when the rat pit was almost as much a national institution in England as the bull ring still is in Spain, rat catching was a thriving trade, and professional rat catchers of that day were firm believers in the use of scents for attracting rats. The experiments made by the Massachusetts State Board of Agriculture seem to prove that certain scents are attractive to some rats, but it is possible that these odors serve more to disguise the smell of the trap than to lure the rats. When the trap gives off an odor of iron rust, rat blood or human perspiration, no doubt the experienced rat takes the alarm. Therefore the expert rat catcher cleans the trap, disguises the odor or substitutes some strong odor for it. Whatever the reason, the scented traps caught more rats than those unscented. While trapping for three days in two barns with cleaned, covered and scented traps, handled with clean or scented gloves, we caught twenty-three rats. Three days' trapping with uncovered and unscented traps secured but three. To get the best results traps should be handled only with gloves and with great care and gentleness. Throwing or kicking the traps about is likely to put some of them out of action. The leather gloves used in trapping should not be handled, should

FIG. 1.—CARE PAYS IN TRAPPING.

Twenty-three rats trapped in two barns in a few days by clean, scented and concealed 10-cent traps, with a few mice taken incidentally. Trapping with uncovered and unclean traps yielded only three rats in the same buildings. See page 44. (Original photograph.)

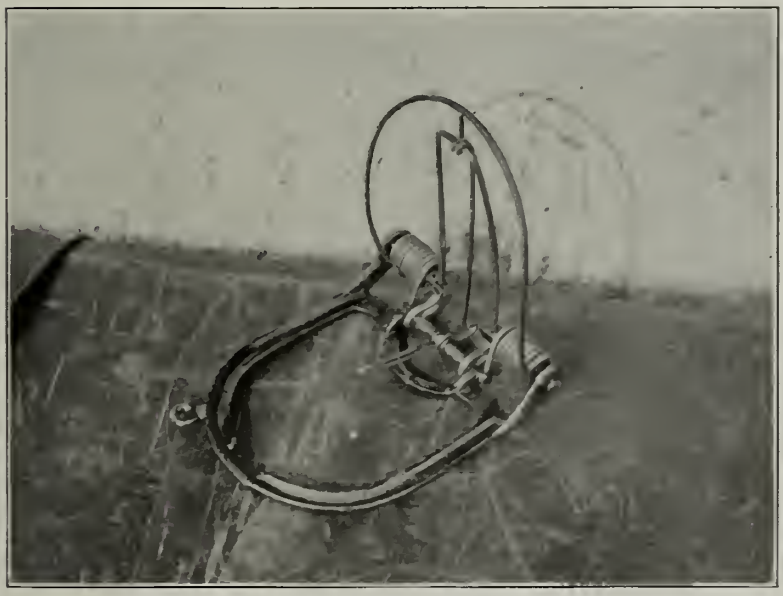


FIG. 2.—THE SCHUYLER TRAP.

Metal traps like this are very durable and effective. (Original photograph.)

be kept as clean as possible and should be scented with a drop or two of the oils of anise, caraway or rhodium which have been proved efficient in overcoming human scent. Traps should be well cleaned, before setting, with plenty of water and a brush (or scalded), and dried before a fire. In scenting the bait, a *single* drop of oil of anise or caraway is dropped on a piece of paper, and this paper rubbed on the bait. This may be used for several traps. More is unnecessary and may repel the rats. Where gloves are not at hand the following procedure is recommended by rat catchers: —

Take a large handful of oatmeal; drop on it four drops of oil of caraway or anise; rub it through the hands until the oil is well mixed with the oatmeal, and continue to do this occasionally while handling and arranging the traps. This is intended to take up the perspiration and disguise the odor of the hands. Rat catchers in olden times were accustomed to make a trail from trap to trap by dragging from a fishing rod a herring, a rag scented with oil of caraway and another, or a calf's tail, scented with the oil of anise. The soles of the trappers' boots were anointed. Trappers also used mixtures of various oils for drawing rats, among which were the oil of rhodium, oil of lavender and "oil of rats," which, as its name implies, was tried out of the rats themselves.[1]

Where one scent is not successful, or the rats learn to associate it with the trap, another may be tried, or the traps may be washed and smoked. Such precautions may not be necessary in a grocery store or a bakery, or wherever the food is handled constantly and the human odor is over everything, but, ordinarily, traps will give best service if cleaned and concealed. Steel traps or flat traps may be covered with chaff, bran, cut hay, sawdust, feathers or dry earth. When a trap is covered with bran or chaff the material should be strewn over a considerably larger space than the trap covers. Two or three traps may be set near together, but they should not be set so near that one in springing will spring another by striking or jarring it. When a steel trap or a guillotine trap is set in meal, shorts or earth, a bit of some light fluffy substance, like cotton, should be placed under the trigger or pan before

[1] Rodwell, James, The Rat, London, 1850, pp. 249–251.

it is covered. This will prevent the covering material from getting under the pan and packing so as to stop the trap from springing.

A trap should be set so gently that it will spring at the least pressure on pan or trigger. In setting, the fingers should not be used to depress the pan; a rolled-up paper wears better, and if the trap springs on it, it will not bend the wire.

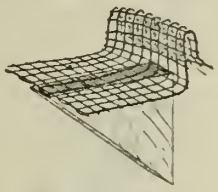
Catching the Experienced Rat. — Every one who has trapped rats knows that sometimes after most of the rats in a building have been caught there remain a few cautious old rascals that successfully defeat all efforts to entrap them. These may be taken without great difficulty if their food supply, other than that furnished by the traps, can be *completely* shut off, otherwise they may continue to defy all efforts to take them, but if the trapper is persevering they will be captured or driven away in time.

The steel trap (if covered and its odor disguised or concealed) is one of the best devices with which to deceive rats. Some experienced rats are almost as cunning as a fox. Indeed, some of them are so much wiser in their way than most people who attempt to trap them that trapping often is given up in disgust.

A close study of the habits of the rat is necessary for successful trapping. The trapper should remember that the rat always goes barefoot. When a cautious rat, in its nocturnal rambles in search of food and led by delectable odors, places its bare foot on cold, clammy iron or steel, the touch no doubt strikes a chill to its very marrow and raises an instant alarm. Also, if the trap is fully exposed to view it may arouse the rat's suspicions before dark. Hence the rat catcher covers the trap.

When the steel trap can be set under water it gives out no odor, and if the rat cannot see it readily, particularly at night, he is easily caught and drowned at once, which puts an end to his suffering. The trap may be set on a stone or a clod under water, and the bait may be attached to the pan so as to show above water. When the trap springs, the rat, caught by the head, springs with it, goes into deep water and is held down by the trap and drowned. A trap set under water in a little run leading into a fish hatchery pond caught a rat every night for nearly two weeks.

Sometimes an "educated" house rat defies all efforts to entice him into a trap. In such a case the following plan often succeeds: take a large pail or firkin (if there is danger of leakage a galvanized iron bucket is best) and a piece of cellar wire netting about 4 inches wide by 8 inches long. Bend the netting so that it will hang over the edge of the pail and form a shelf inside parallel to the bottom of the pail and about 2 inches from the top. A triangular piece of wood may be nailed under the shelf as a bracket to support it, so that it will hold the weight of both trap and rat. (See cut.) The trap may be dipped in melted wax to keep it from rusting, and set on the shelf with the bait tied to the pan. The pail should be set in some dark, unfrequented spot in attic, closet or cellar, where the rats run, and filled with water so as to just cover the trap and pan but not the bait. I have used a thin chip, tied on top of the pan, on which the bait was fastened to keep it dry. The bait must be handled only with clean gloves. The pail should then be nearly or quite full. Now a board is laid from the floor to the top of the pail, and rests on the pail's edge or on the wire so as to bring its top level with the edge. (See Plate VI., Fig. 1.) A little grain is scattered along this board. This trap will be most successful if there is no other water near by that the rat can reach. If he can get both food and drink here he will sooner or later try to take the bait, when, if the trap is carefully set, it will catch him by the neck and he will jump in and land on his head in the bottom of the pail, where he is either killed by the trap or held down by it and drowned at once. The other rats will not understand his disappearance, and the trick may be repeated. This set must be carefully made and the trap kept covered with water. In winter it can be used only in heated buildings, where water never freezes.



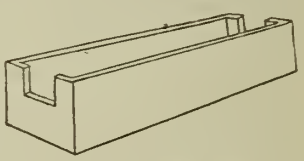
Wire shelf for water trapping.

This arrangement is sure death if the right trap is used and the set is properly made. A washtub may be used and four traps set, which will be likely to increase the catch, but all the shelves and traps must be carefully adjusted and the tub leveled exactly, so that all the traps may be entirely covered

with water. All traps set under water for rats should be sprung and reset about twice a week and always set lightly. These precautions neglected, a small rat might not be heavy enough to spring the trap. The trap shown near the bottom of the pail (Plate VI., Fig. 1) is commonly sold as a rat trap. It is a very handy trap for this purpose but has two bad faults, — the pan is too large and the spring under the pan throws it up when the trap springs. If the rat happens to put foot or nose down on the edge of the pan it comes so little within the sweep of the jaws that it may be thrown out by the upward lift of the spring under the pan, or pulled out by the rat as the trap closes. In that case the cautious rat may not come again. The No. 1 "Newhouse" trap, having a small pan and a side spring, is best. The above plan cannot be used out of doors where the trap can be seen and where domesticated animals or birds can get at it, but rats may be trapped out doors in summer or at any time when water will not freeze, without danger of catching dogs, cats or poultry, if the trap is set in a covered trough.

Newhouse trap.

A watertight trough or open box must be made of boards or cement. It may be 12 inches long, $4\frac{1}{2}$ inches wide and 3 inches deep, inside measurement, or larger if the trap to be set in it requires it. In the upper part of each end an opening for the entrance of the rat is made in the center, $2\frac{1}{2}$ inches wide and $1\frac{1}{4}$ inches deep. (See cut.) This allows the rat to come in only where the pan of the trap is ready to receive him. The trough must be set level into the earth up to the bottom of the opening, and filled with all the discolored water it will hold. The water is discolored so that the rats cannot readily see the trap. The trap should be set in the trough under water, and next to one of the entrances, and if the trough is long enough two traps may be set, one at each end. The trough may then be covered with a board or box projecting well out over the entrance holes, or two small drain



Trough for steel traps.

tiles may be used as leaders, or a drain may be left open and the trough placed at its mouth leading into it. The whole thing should be so covered as to weight it well, render it dark, and keep animals larger than rats from getting at the traps. Thus advantage is taken of the natural tendency of rats to enter dark drains and dogs and cats are protected.

Traps may be set without bait, as bait sometimes arouses the suspicions of the rat. Twelve traps set in this way caught eleven rats in one night, and a gardener on an English estate catches from 100 to 150 rats in these troughs during the mild English winter.[1] A similar trough possibly might be made of split tile of 5 or 6 inches interior diameter.

A rat hole may be made in or under a rat-proof henhouse or shed leading into a long rat-proof trough or covered way, with a wire-covered opening at its farther end. The cover to this may be raised, and if a trough it may be filled with water and a number of steel traps set in it; if merely a covered way, flat traps. The rat having gone in, must come out again, running the gauntlet of the traps both ways.

When a trap is not set in water it should be a large one and the bait fastened to the pan; then when the trap springs it will take the rat "amidships" or by the neck, and shut off his breath at once, instead of catching him by the leg and allowing him to suffer torture.

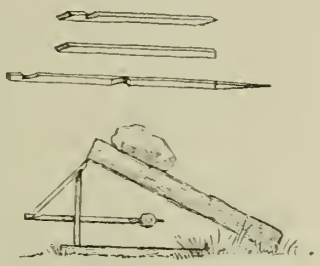
In summer, outdoors, or in a shed or cellar at any time, an old rat may be taken by placing a little cotton under the pan of a steel trap, covering the trap entirely with loose dry earth and using some strong-smelling bait, like fish, which may be covered by a little chaff. Rats like to dig up things. In uncovering the bait your rat may be nipped. This plan works effectively and continually. New steel traps should be covered with earth for a day or two or well smoked, to take away the smell of the iron, before using them. Where rats refuse to take a bait tied to the pan the following plan may succeed: a dry goods box may be sawed off to two inches in depth and filled with bran or sawdust or some coarse meal. This may be set in a place frequented by rats and unbaited traps set in it close to

[1] The Field (London), Vol. 121, March 15, 1913, p. 493.

the sides, with the chains fastened radiating outside, so as to keep a caught rat from getting into more than one trap. Cover all with bran in which scatter small bits of any alluring bait. To render the box still more attractive, an upright stick about a foot long may be fastened in the center with a choice tidbit, large enough to be conspicuous, tied to the top. Some strong-smelling fish or ancient meat will do. Some rat is likely to be caught while dancing around the pole. The box should be moved rather frequently and a different kind of bait tried every few days. If the rats learn to climb the stick and get the bait, avoiding the trap, the bait may be hung by a string. In prancing around after the swinging bait the rats may get incautious. When they have learned to avoid the box a quantity of bran, fine sand or fine sawdust may be spread near the rat holes, and when the customary trails of the rats are shown by the tracks, unbaited traps may be set carefully where they run, and covered by the bran or other material; or an old chair may be set against the wall, the trap set beneath it, bait tied to the pan and the seat of the chair covered with straw hanging down to the floor on all sides; or a trap may be set near a rat hole and covered with a light weight, dark-colored cloth; or set in a bucket in meal or bran, with a piece of toasted cheese tied to the pan, and the bucket covered carelessly with a weighted cover or board having a rat hole made just over the trap. If the rat jumps in he may spring the trap, or he may try the cheese and be caught by the neck, or he may tread on the pan in jumping out, with results disastrous to his peace of mind. If he does not go in, remove the cover and try him that way, covering the trap with meal.

In covering steel traps with cloth, sawdust, meal, etc., care should be observed not to get much of the material over the jaws near where they are hinged, as that will interfere with the proper closing of the trap. Some trappers use a "bed" of feathers and other light materials in which food is scattered, until the rats come nightly, then carefully cleaned, smoked traps are buried in the bed. For this purpose good snap or "break-back" traps may be used in place of the steel trap, but the steel trap is best.

Sometimes a weighted deadfall will kill a cautious rat. A bit of plank, well weighted, supported with a "figure 4" trigger, built to "throw clear," covered with straw and enticingly baited, may do the business. (See cut.)



"Figure 4" trap and details of construction.

Rats drink a great deal, and in houses where there are no wells they resort to any accessible water tanks in garrets or closets. Traps set in dark places near such tanks are likely to bring results.

When visiting a trap it is best not to go too near it or touch it for several days, unless it has been sprung. If a rat has been caught the trap should be cleaned and reset. If the trap has been sprung and has failed to catch him, reset it carefully and rebait it as before. In time the same rat may be caught.

When rats become so wary that they will not spring concealed traps, watch for them and mark their runways, and set unbaited and uncovered traps there. If such a trap is set on a narrow joist, or where rats are known to run, they will see it, become accustomed to it and may in time become careless and spring it by jumping or running over it. I have taken one old rat in this way on the third night after setting the trap. This rat had not touched carefully set and baited traps.

Rat Bait. — Rat catchers and other experts differ regarding the best bait for rats. Some believe that rats should be baited with the food to which they have been accustomed, — fish should be used in a fish market, meat in a meat market, and grain in a stable or grain store; others contend that the opposite plan secures best results. In the experiments made by the Massachusetts State Board of Agriculture a combination of both plans was successful. Where rats could get only grain, oatmeal or rolled oats was used in small quantities about the traps; a little was sprinkled on the tread and a light trail of oatmeal was laid from trap to trap, while the traps were baited with bacon, cheese, sausage, or some other animal food. Sometimes when rats are feeding on grain some strong smelling animal

food, such as toasted cheese, bacon, sausage, fish or fish heads, will attract them where grain will not. The bait commonly used for the flat traps (Plate VI.) was a small bit of fried bacon. When forty or fifty traps were to be baited quickly, a piece of bacon was fried, cut into pieces with scissors, each piece pressed into the hole in the tread of a trap, and the partly melted grease poured in until the hole was filled. Also, strong smelling cheese was used; it was toasted, and, while still hot, forced into the hole in the tread with a knife blade. These traps require very little bait. Other traps, where the bait must be tied on or hooked on, may be baited with cheese, bacon, corn, or any tenacious meat or vegetable bait. Some writers assert that a rat has no choice of food, but I have known rats to pay no attention to stale, dirty bait for weeks, and to be caught immediately when the bait was changed for something more enticing. It is a good plan to change the bait now and then, using some tempting food other than the one commonly employed. Cakes, doughnuts, honey, syrup or molasses, chicken, chickens' feet, scraps of raw or cooked beef or pork, prunes and other fruits and fresh vegetables all may be useful.

The Wire Cage Trap. — Where rats are numerous, particularly about slaughterhouses or meat markets, the large nineteen or twenty inch French wire cage traps may be useful. The smaller cage traps, made of light wire, often will not hold strong, full-grown rats, which will force the wires apart, but the larger traps, if made of stiff, strong wire, well bound with lighter wire, will hold a rat of any size. More than 25 rats, mostly young ones, have been taken in one of these large traps in a single night, and 200 have been taken in a season, but this is very unusual. Many of the smaller wire traps are in use, and though ordinarily set without any precautions, some success in their use has been reported by many Massachusetts people, but wire traps are not commonly nearly as effective as snap traps properly handled, and young rats are largely the victims. In many cases, where wire traps are exposed openly to view, rats cannot be enticed into them, and if once rats are caught in one their fellows may avoid it afterward. In such a case, where a trap had been set fruitlessly in a barn for weeks, baited with grain, I pushed it aside against a horse stall,

changed the bait to fried bacon and fish, covered it with two meal sacks and a heap of hay, leaving a small opening at the front, and the next morning six rats were inside. If this stratagem be tried in cold weather it is better first to cover the trap with short boards, to prevent the rats from drawing in bagging and hay for a warm nest, and so interfering with the working of the trap. Rats like to burrow in dark and obscure places under hay or rubbish to find food, and advantage should be taken of this tendency; but the plan may not succeed the second time. Some trappers have been successful by keeping one rat, a female, constantly in the trap, feeding her well and using her to entice others. Failing in this, the location of the trap may be changed, and it may be baited daily, covered, and left open at both ends, so that the rats can run through it freely. When they begin to run in and take the bait nightly, they may be fed thus for several days, and then the trap may be baited well and the door at the back closed. Prof. David E. Lantz of the Biological Survey tells me that a merchant of his acquaintance succeeded in catching many rats by enclosing the trap in a box, with a hole opposite the entrance. He then left the trap open at the back, so that the rats could go in the front way and feed, pass out at the back door, and jump out at the top of the box. When all the rats had become accustomed to feeding there, he fastened down the cover of the box, and the next morning the rabble was within. The editor of "The Field" states that not a rat would touch his wire trap when it lay in the open, but when it was taken up, baited with refuse fish, and covered with an old mat, some "lovely specimens" were found entrapped the next morning.[1]

A correspondent asserts that he placed one of these traps in a meal sack, leaving the mouth of the sack open and using anise, and that the next morning he had a "trap full" of rats.

Cornstalks, straw, old rags and any rubbish may be used to cover the trap, but if set on the ground it should be placed upon a board, to prevent rats burrowing underneath and securing the bait through the wires. All the precautions heretofore recommended for handling other traps, such as smoking the trap and handling with clean or scented gloves, are ap-

[1] The Field (London), Vol. 89, May 1, 1897, p. 692.

plicable here. The following directions by Dr. W. Colby Rucker of the United States Public Health Service are excellent: —

Before setting, the lever on the trap should be tested to see that it works properly. The trap should be placed on a hard surface, with the rear end a little higher than the entrance, so that the trap will close promptly. When setting the trap in the open it should be fastened to a board on which about an inch of soft dirt has been spread. Place the trap where the rat usually goes for food, or in a runway, and disturb the surroundings as little as possible. It is sometimes well to place the trap near where there is dripping water, as the rats come there to drink. If the trap is set in hay or straw or wood it should be covered (with the exception of the entrance) with this material. . . . The bait should be fastened to the inner side of the top of the trap with a piece of fine wire, so that the first rat in cannot force the bait underneath the pan and thus prevent the entrance of other rats. A few grains of barley should be scattered near the entrance of the trap and a small piece of cheese or meat fastened to the pan with a piece of wire. It is often well to touch the pan with a feather which has been dipped in oil of anise or oil of rhodium. Before leaving the trap it should be smoked with a piece of burning newspaper to kill the smell of the human hands or the rats which have been in it. Do not handle the trap after burning it out. When trapping in a neighborhood where rats are known to exist the traps should not be moved for three or four days unless they have rats in them, as it is well for the rats to become accustomed to seeing them and thus become careless about entering. It is not wise to kill rats where they are caught, as the squealing may frighten the other rats away. [1]

The three styles of trap given above ought to be sufficient to clear any premises of rats. There are homemade traps, however, which have been often and highly recommended.

Barrel Traps. — Prof. David E. Lantz speaks of a writer in the "Cornhill Magazine," "about sixty years ago," who gave details of a barrel trap by duplicating which over 3,000 rats were caught in a warehouse in a single night. The rats were enticed for several nights to the tops of barrels covered with coarse brown paper, upon which bait was placed. Then a cross cut was made in the paper, so that afterwards the rats fell into the barrels. (See cut.)

Another plan is to make a barrel head of thin light wood or cardboard, fixed to turn on a pivot. This tip-up is fastened

[1] Treas. Dept., Public Health and Marine Hospital Serv. of U. S., The Rat and its Relation to the Public Health, by various authors, Washington, 1910, pp. 154, 155.

up and baited until the rats feed nightly upon it, and then is released. (See cut.) "Pickett" says that an acquaintance of his tried this and found it a "horrible" success. In three days

Barrel traps: 1, with stiff paper cover; 2, with hinged barrel cover; *a*, stop; *b*, baits. (After Biological Survey.)

while he was away from home it engulfed 7 rats, 3 spring chickens, 1 high-bred hen and 4 prime young turkeys. Evidently, like most traps, it failed to discriminate.[1] Still another plan is to fix a narrow tip-up on the edge of an open barrel, one edge of which rests on a shelf while the other projects out over the barrel, with the bait fastened to the end of the tip-up.

Much has been written about these traps. Stories are told of the great numbers of rats caught in them. It is said that a brick should be stood on end in the bottom of the barrel in water enough to expose its upper end. The first rat to go in is said to climb on the brick. The next fights the occupant for possession of the island, and the "row" is said to attract all the other rats, who immediately, fired with curiosity or the zeal of the explorer, plunge in and join battle, until only one rat is left alive. All this sounds interesting and encouraging, but in the experiments of the Massachusetts State Board of Agriculture such traps were arranged in several infested stores and buildings, and no one of them ever caught more than a rat or two. I have seen a barrel trap, specially constructed and guaranteed to exterminate the rodents, into which no one was ever able to entice a rat. Success with these traps may be possible if they can be constantly attended by a skillful trapper, and if the rats can be denied food elsewhere, but the traps

[1] The Rural Library, Vol. 1, No. 2, How to rid Buildings and Farm of Rats and Other Pests of Like Character, May 19, 1891, pp. 8, 9.

must be kept constantly baited for days if not for weeks, until the rats have become accustomed to feed on them, trails must be made to entice the rats to them, and it is often necessary to provide a bridge or other means of reaching the barrel top, along which grain, crumbs or other bait must be kept sprinkled. All this requires room, and the arrangements must be left undisturbed. Where paper is utilized, it must be of a stiff, springy quality, so that when cut it will spring back into place when the rat has fallen through. Bait must be fastened to it, so that it will not fall in after the rat, and every barrel must be carefully tended and watched for a long time. The tip-ups must be nicely adjusted, so that they will not bind and will return quickly to place when tipped. Much time and trouble are required to make and adjust them carefully. In the ordinary store or farm building, the arrangement of the barrels is likely to be constantly changed by employees in the exigencies of business; the paper, if used, torn, and the whole plan upset. In a word, the scheme is not practicable except perhaps where all the conditions can be controlled by a skilled man.[1]

The following proceeding is simpler and has given better results in the experiments undertaken by the State Board of Agriculture: —

A barrel, a large tub or a great kettle or cooker may have a false bottom made for it, which may be covered with chaff, among which grain, meat scraps, cheese, crumbs, etc., may be scattered, or the receptacle may be partly filled with any loose material, the top of which may be leveled, covered with chaff and baited. The rats must be trailed and enticed to this, and then fed there nightly until all in the building have found it. It is better to have a little water in the bottom from the first. When the rodents have become confident and hold nightly revels among the chaff, take out the false bottom or filling some evening, put in about 14 inches of water, scattering enough chaff on the top to cover it, with a few enticing bits of bait. This trap, properly handled, brings results, but no such trap can be used in winter in buildings where water will freeze, except by

[1] Deep boxes are sunk in the ground on game preserves just outside the wire pens, and two tip-ups are arranged for the top of each box, so that any small animal coming from either side running along just outside the wire will fall into the box. Such traps, properly set and attended by skilled gamekeepers, are very successful. Poultrymen might use them.

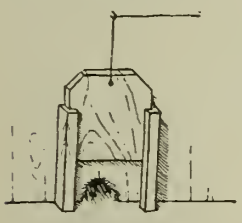
the use of extremely salt brine, and winter is the season when rats are most troublesome in buildings. Sometimes rats may be enticed into a deep barrel or can, such as a garbage can, and if the receptacle is about 30 inches deep they cannot get out. I have known three or four to be taken in a night by using a heavy cardboard box about 30 inches deep and sprinkling bits of meat, cheese and crumbs in the bottom. A deep garbage can sunk in the earth on a rat trail, with grain in the bottom, claimed some victims.

The jar trap (see cut) is said to be very successful.

A Burmese trap. (After Biological Survey.)

Rat Electrocution. — Metals charged with electricity are said to have some attraction for rats, and accounts of rat electrocution have been published. Dr. Rucker says that rats have been eradicated in cold-storage warehouses by suspending a bait between two heavily charged overhead wires at a point where the insulation had been removed. The hungry animal creeping along the wires shunts the current through its body, and, falling unconscious into a tub of water, is drowned.[1]

Rat Fence and Battue. — A movable fence or a wire netting of about one-half inch mesh, or even strong cloth or canvas and stakes, may be used to enclose piles of wood, rubbish, shocks or stacks of grain, and the material may be shaken free of rats and thrown over the fence, when the exposed rats may be easily killed by dogs or by men armed with clubs or wide flat shovels. Many thousands of rats have been killed in this manner. Rats may climb the fence, but if closely followed they will not have time to get out of the enclosure.



For grain room.

Grain-room Trapdoor. — A large grain bin or a grain room may have an opening made to admit rats, which opening may be closed by a little sliding door operated by a string from the outside of the building. In the evening, when the rats have gone in, the farmer

[1] Rucker, Wm. Colby, Public Health Reports, Vol. 27, No. 29, July 19, 1912, p. 1133.

lets go the string and the trapdoor closes of its own weight. Then he enters with a light and no rat escapes. A box may be set near the wall and as the rats run behind it it is pushed hard against the wall. This is one of the best traps known.

Rat Poisons and Poisoning.

Poison skillfully and scientifically administered will destroy or drive away rats. Where rats are numerous, poisons are much more economical of time and money than traps, but rarely more effective, and the use of poisons is dangerous and generally cannot be recommended. I have used them only in the experiments conducted by the Massachusetts State Board of Agriculture, never having found poisoning necessary on my own premises. Nevertheless, notwithstanding the dangerous character of rat poisons, people will continue to use them, for scattering poisons involves less trouble and expense than setting traps. Therefore, directions for the use of poisons are given below, but with repeated warnings against carelessness.

There is always some element of danger to man and domestic animals, and often to wild birds and mammals, when poison is used. All poisons should be carefully and conspicuously labeled (see cut). They should be kept far from the medicine closet or the pantry, and should be locked up or hidden where children, servants and fools cannot get at them.

CAUTION.

POISON.

It is necessary here to point out in detail many ways in which accidental poisoning may occur. Cats or dogs may eat poisoned rats, with deplorable results. Where poisoned meat, bread, fats or cereals are used, they may be eaten by children and dogs, cats, poultry, etc. Where poisoned grain is exposed out of doors wild birds and poultry may be endangered. Poultry, dogs, cats, pigs and calves have been poisoned fatally, while children and adults have been poisoned either unintentionally or purposely when rat poison has been left incautiously about the house. Wherever poison is used about dwellings every care should be observed to cover securely water, milk or any beverage. As poison "drives rats to drink" after they have partaken of poison they drink whatever liquid comes in their way. If nauseated by the poison they

are likely to vomit into the liquid, thus poisoning water, milk, beer and other beverages. If there is no other water they will climb or fall into open wells, which endangers the health if not the life of people who partake of water from such wells. If there is nothing for them to drink in the building they will get out of doors if possible, and take dew, snow or water from drains, etc. Rats are very resistant to some poisons and not many are found dead after poison has been used. I have found a few dead in such cases near or in water, sometimes many rods from the place where they were poisoned. The dying also

Poisons are impartial.

retire to holes in the ground. Rats sometimes carry poisoned food about, leaving it where birds, poultry, dogs or cats can get it.

The use of traps will show definite results, but in the use of poisons the exact effect cannot be determined. When poisons are used on confined rats the results can be seen; but rats confined with poisoned food must eat it or starve, as they can get nothing else and cannot go elsewhere to feed. When poisoned food is put out for free rats some may be found dead, others may die in their holes. It is impossible to gauge the amount of poison that any rat may take. One may take just enough and die, another may take too much, which acts like an emetic, and the experience may or may not drive the rat to other quarters. Another may leave in search of water and never come back, or, finding water at hand, it may die in a wall or under a floor of a building, with the usual disagreeable consequences. Others may not touch the poisoned food, while still others may take just enough to warn them, but not enough to be fatal.

Certain proprietary poisons are advertised to embalm rats or dry them up. Of others it is said that the rats "don't die in the house." It is almost needless to say that these claims have very little foundation in fact. There is no poison known which a rat can eat and retain enough of to embalm its carcass,

and now and then a poisoned rat may die in the house in spite of all precautions, but if the directions hereinafter described are followed, this mishap is not likely to happen often.

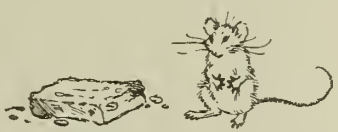
There is nothing new known in rat poisons. Those most commonly used are arsenic, phosphorus and strychnine. Common arsenical poisons are white arsenic or arsenious acid, and two other forms of arsenic, Paris green and arsenate of lead (London purple is rarely utilized). Squill, *nux vomica*, cyanide of potassium, corrosive sublimate (bichloride of mercury), hellebore, henbane, hemlock seeds and some other poisons have been used with varying results. Squill (*Scylla maritima*) is toxic or poisonous for rats, and in the quantities prepared for them is not fatal to larger animals. As arsenic, strychnine or phosphorus form the basis of the greater part of all the successful rat poisons used in this country, and as they are perhaps as effective as any in use, the various means of utilizing them will be considered here. The reader may inquire, if these poisons are effective, why recommend more than one? Unfortunately, with poisons, as with traps, we depend on the cooperation of the rat, which we cannot always secure. If the rats have tasted elsewhere the combination that we offer them they may refuse to touch it, and it may be necessary to try some other formula; or they may have already taken small doses of arsenic, for example, and may be somewhat resistant to its effects. Hence a number of different poisons and different preparations of each are given.

The chief difficulty in the effective use of arsenic and strychnine is to disguise them so as to get them into the rat in sufficient but not excessive quantity. Strychnine has a bitter taste; arsenic is more or less gritty in the mouth; phosphorus is easily detected, yet rats seem to like it, and for this reason it is one of the most effective rat poisons, *if properly prepared and used. No one should use any of the recipes or formulæ given here without first reading all that is written in this bulletin about poisons and their uses.*

Arsenic. — Arsenic (arsenious acid) being chemically unchangeable retains its toxic properties indefinitely under all conditions, and may be easily disguised, therefore it should be

as reliable and effective as any poison. Professor Lantz writes me, however, that the Public Health Service, since distributing poisons at San Francisco and New Orleans, has become convinced that arsenic is a very unreliable rat poison. Nevertheless, it has been used effectively for this purpose for more than a century. On Thompson's Island, in 1907, when the rats had become so numerous that they were destroying everything edible on the farm, they were reduced almost to harmless numbers at once by quantities of ground fish and arsenic and sandwiches composed of bread, butter and arsenic. Five hundred pounds of fish and 50 loaves of bread were used.

Arsenate of copper, in the form of Paris green, which is much used as a commercial rat poison, has no advantage over white arsenic, except that of color, which renders it conspicuous, but it has the disadvantage that it contains less poison to the pound, and most of the commercial Paris green is adulterated. Arsenate of lead is a slower poison, of less strength than white arsenic, and though now much used it is not recommended. London purple has the advantage of conspicuous color. Arsenate of soda has not been used as rat poison so far as I am aware. White arsenic is a very dangerous poison in the hands of a careless person, as it somewhat resembles flour; it may be bought at a low price by the pound from wholesale druggists. A time-honored way of administering arsenic to rats is to place pieces of bread and butter sprinkled with sugar near their runs night after night, until they have learned where to look for them and their suspicions have been allayed, then to spread *finely powdered* arsenic thinly over both sides of slices of bread and spread soft butter over the arsenic, or, better, mix arsenic with the butter before spreading, and sprinkle with sugar as before. The poison becomes incorporated with the butter, and is eaten without suspicion by the cunning rodents. Sometimes, however, the sly rat will eat the bread and avoid the poisoned butter, and it is better to melt the butter, stir in an equal quantity of arsenic, and pour the mixture on both



Pain and apprehension.

sides of the bread, so that it will soak in. The bread may be then cut in pieces about an inch square and each piece well sprinkled with powdered sugar. One piece should be fatal to any rat that will eat it.

This or any other poison should be put down at night in places where no dog, cat or child can get to it, and the remnants picked up and buried deeply early the next morning. Poisoning rats in dwelling houses is not recommended, but if all water and other liquids are safely covered or otherwise disposed of, poisoned rats usually leave if possible and go elsewhere in search of drink, dying in fields, outbuildings, swamps, or on some neighbor's premises where water may be found. Liquids in open dishes, bottles or cans, and water tanks in closets, attics or elsewhere, should not be overlooked in covering. When poisoning rats in barns and outbuildings it is well to have a small pan containing a little fresh water for rats to drink from for several nights in advance, and then to stir a tablespoonful of arsenic into the water on the night when the poisoned food is put down. Thus the rats, in their attempt to get relief, imbibe more poison, making their election sure. When rats once have learned the effects of arsenic those that recover will not touch it again unless it can be served to them in a form that they cannot recognize. Also, some rats will refuse at the beginning to take it in one medium, but may in another; hence the different combinations in which it is served, a few of which are here given. I wish to call attention to the wide variation in the percentages of arsenic in these preparations.

Arsenic and lard: Dr. Rucker says that the use of poisons has proven "very efficacious" in the rat-destroying work of the department in San Francisco, where, he asserts, arsenic and phosphorus have given very good results. Arsenic, he says, should be incorporated in some fatty materials, "such as lard, sweetened with sugar, flavored with anise or musk and colored a light pink" to denote its dangerous character. The lard readily takes up arsenic, which, so disguised, is usually taken by rats. A correspondent writes that he picked up three dead rats "near the watering trough" the morning after such a bait had been used. The proportions were roughly given by him

as about a tablespoonful of arsenic to half a pint of melted lard, well mixed when hot and then cooled. Such a mixture may be used to advantage in the coldest weather, as it hardens but does not freeze. This contains only about $8\frac{1}{2}$ per cent of arsenic. A heaping thimbleful should be sufficient for one rat.

Arsenic, lard and corn meal: Dr. Rucker has sent me from New Orleans the following formula: arsenic 20 per cent, lard 34 per cent, corn meal 46 per cent. (Note the per cent of arsenic.) Half a thimbleful of this mixture placed in a rat hole ought to kill any rat that eats it. Cheese, mutton fat, and other bases may be used to deceive rats. Arsenic should be *finely* powdered when used as a rat poison, and when sugar is used with it brown sugar, which is moist, probably is best, but powdered sugar, which resembles arsenic somewhat in appearance, may disguise it better than the ordinary granulated article.

Waterton, the English naturalist, whose house was overrun with rats in his absence, gives the following as an effective mixture: —

Arsenic and oatmeal: a washbasin full of best oatmeal, two pounds of coarse brown sugar and a good dessertspoonful of arsenic, well mixed. A tablespoonful should be pushed well into every rat hole.[1] Assuming that a washbasin holds three quarts, the quantity of arsenic as compared with the other ingredients would be about $\frac{1}{5}$ of 1 per cent.

As washbasins now made hold from two to six quarts, some more exact recipe is needed, and this is given by Professor Lantz, as follows: take a pound of oatmeal (not rolled oats), a pound of coarse brown sugar and a spoonful of arsenic; mix well together and put the composition into an earthern jar. Place a tablespoonful in each run frequented by rats.

This formula has been given a wide circulation. It has two great advantages: (1) it is a nearly dry mixture and cannot freeze, and therefore can be used in the dead of winter, when rats need food most and are easily poisoned; (2) it does not stick together, and therefore cannot be carried about by rats, like bread and butter or arsenic pills, and perhaps left where domestic animals can get it, but I have never known this

[1] Waterton, Charles, Essays on Natural History, 1871, p. 240.

formula to clean out the rats, probably because the percentage of arsenic is much too small. Possibly the dose — a tablespoonful — might kill a rat now and then were he to eat it all, but there is no certainty that it will be eaten by one rat. Probably it is a safe practice in rat poisoning to mix so large a percentage of poison with the food that if a rat eats only a little he will die and as a means of safeguarding the rat against eating too much and then vomiting it, a small amount may be placed in each rat hole. When about 10 per cent of finely powdered arsenic was used in the mixture the rats disappeared, and some dead rats were found, but in most cases only a part of the tablespoonful was eaten. Less than half a teaspoonful would probably be an ample dose of the 10 per cent mixture.

When rats live in holes in the ground in winter they may be poisoned by this mixture in very cold weather by moistening dry earth or clay with water, thus making a quantity of mud or wet clay, placing a teaspoonful of the mixture in each rat hole and closing every hole with mud. This will soon freeze hard, and the imprisoned rats must sooner or later eat the poisoned food or starve.

The following rat catchers' recipes are abridged from Rodwell: —

Arsenic and flour or malt: a quart of good flour or malt; mix with it an ounce and a half or two ounces of finely ground arsenic; add ten drops of oil of caraway, two drops of oil of anise, and one drop of oil of lavender. These should first be rubbed well up in a handful of flour or malt, then stirred in well with the whole (here we have about 3 per cent of arsenic, which I should increase to at least 8 per cent). Malt may be procured of wholesale druggists or brewers.

Arsenical paste: take one ounce of finely powdered arsenic, one ounce of fresh butter, and make them into a paste with oatmeal and honey; rats eat of it greedily, then seek drink. (At least three ounces of oatmeal should be added, with honey enough to moisten.) This ought to give about 15 per cent of arsenic. As this is a most deadly thing, one should be very cautious in its use, and always wash the hands afterward.

Arsenic pills: take two ounces of fine flour, two ounces of lump sugar, beat to a powder; ten drops of honey, one ounce of

arsenic, ground very fine, six drops of oil of rhodium, eight drops of oil of caraway; mix them all well together, and make them into a stiff paste with two or three spoonfuls of milk (over 6 per cent of arsenic in this); then cut into pills about the size of peas, and lay them where the vermin frequent.[1]

Johnson says that the following mixture is effective, and that rats never refuse it if first fed and left unmolested until they become bold and unsuspicious. A handful of good oatmeal mixed with a handful of newly ground malt and an ounce or an ounce and one-half of arsenic (about 19 per cent); make into dough and then into pills the size of a pea, and throw carelessly into rat holes. One of these pills carelessly twisted up in a piece of paper is said to rarely fail of its object.[2]

Arsenic, corn meal and eggs: mix twelve parts by weight of corn meal and one part of arsenic into a thick dough with white of eggs.

Arsenic and fish: this is a combination used by professional rat killers and is very effective where rats will eat it. Care should be taken not to handle the fish or arsenic unless the rats are accustomed to take readily food which has been handled. About half a gill of finely powdered arsenic may be thoroughly mixed with a quart of ground fish. A small fish split open, arsenic rubbed in the cut with a stick and the fish sewed up, may deceive some over-cautious rat. *Poisoned fish must be kept out of reach of dogs, cats and birds.*

Arsenic and milk: Mr. E. H. Reihl in Colman's "Rural World" gives the following plan to clear a barn of rats: each evening after the cows are milked a little fresh milk is placed in a shallow pan where the rats can get it easily. This is continued for a week or more, until the rats get bold, then arsenic is mixed with the milk. Care should be used that no animals or children have access to the barn.[3]

Official arsenical rat poison: as this goes to press I have received from Passed Assistant Surgeon J. R. Hurley of the Public Health and Marine Hospital Service of the United States the following formula, which the department has been using in San Francisco and which, so Surgeon Hurley informs

[1] Rodwell, James, The Rat, 1858, pp. 256–259.
[2] Johnson, T. B., The Gamekeepers' Directory, 1851, p. 45.
[3] Colman's Rural World, Vol. 61, 1908, p. 27.

me, has been evolved in the San Francisco office as the result of experience and experimentation, and has been found there to be practically as efficient as phosphorus. Laboratory experiments show that any rat that eats any quantity of this poison dies within a few days. The quantity of each ingredient given is large and the ordinary householder or farmer might find one-tenth this amount amply sufficient for his needs.

White arsenic, finely powdered,	4 pounds.
Cheese,	4 pounds.
Glycerine,	6 ounces.
Water,	1½ gallons.
Corn meal,	10 pounds.
Black aniline, sufficient to color to a slate gray.	
Oil of anise,	½ ounce.

Melt the cheese with the glycerine and one-half gallon of the water, then add the corn meal and the balance of water, and continue to heat until the corn meal is thoroughly cooked. Then stir in the arsenic and black aniline, and lastly add the oil of anise. It may require more or less water for the above formula, according to the amount of starch in the corn meal, but the quantities as given above are for average quality of corn meal.

It is essential in the preparation of this poison that the arsenic be powdered as finely as possible, in order that there shall be no grit in the paste when completed. The black aniline is added until the color of the paste is a slate gray, the idea being to have the color of the poison approximately the same as that of the surrounding ground. In this manner it does not attract the attention of children, dogs, chickens or other animals.

In the preparation of the paste none of the ingredients should be handled by the bare hands, as there is reason to believe that the odor of the human being attaches to the poison, and in some instances may render the rat suspicious of the poison.

The paste when finished is placed in ordinary tin fruit cans, each can containing four pounds of paste. Each man places one can per day, and each can of four pounds should be sufficient to poison approximately from 800 to 1,000 holes or runs. The poison is placed with a small mixing spoon, somewhat similar

to a cheese scoop, and a piece approximately the size of a hazelnut is placed in each hole or rat-run, in such manner as to be thoroughly concealed from the observation of any person or animal except the rat which uses the hole or run.

The glycerine keeps the paste moist and in a fresh condition practically indefinitely, and it was not unusual to learn of dead rats being found in a vicinity where poison had been placed three or four weeks prior to the discovery of the dead animals.

Probably this is one of the most deadly arsenical mixtures ever invented, but if rats do not take it one of the others least resembling it should be tried. Where they will take no arsenical mixture, as is sometimes the case, other poisons may be resorted to. It will be noticed that the percentage of arsenic in the above mixtures varies greatly. My own opinion is that where the quantity of arsenic is less than 8 or 10 per cent of the whole, the arsenic content should be increased to secure the best results.

Prepared arsenic: sometimes rats appear to be suspicious of arsenic in its ordinary form and will not touch it. John Mayer, an honest old gamekeeper, recommends prepared arsenic, to be used as follows: he takes a pound of fine malt, mixes in three drops of oil of rhodium, two ounces of sugar, eight cloves and a tablespoonful of caraway seeds, beating all fine in a mortar. This is put out in small quantities, until rats take it freely. Then the arsenic is dissolved by pouring muriatic acid upon it and mixed with the bait.[1] The effect of muriatic acid is to reduce the arsenic and make its action quicker. Hence, a large percentage of arsenic should be used, that the rat may be fatally poisoned before the symptoms alarm it. The acid, having dissolved the arsenic, evaporates, leaving the arsenic as a fine powder.

Strychnine (*Strychnia sulphate*). — Strychnine has given results in practical experiments and is a very effective poison, but should never be used in a dwelling except where the rats cannot get into the walls, as the action of strychnine is very rapid. As compared with arsenic it is expensive, but is so quick and deadly in its action that a very small quantity will do the work of a much larger dose of arsenic. Its great draw-

[1] Mayer, John, The Sportsmen's Directory, 1845, p. 148.

back is its bitter taste, which warns the experienced rat, but this warning often comes too late when a very small quantity of the poison has been inserted in meat or fish. If used on grain the taste must be disguised as much as possible with syrup or sugar.

Strychnine syrup may be prepared as follows: add half an ounce of strychnia sulphate to a pint of boiling water; dissolve it, then add a pint of thick sugar syrup and stir well. Oatmeal or other cereals or bread crumbs may be thoroughly moistened with the syrup and distributed in small quantities in rat holes or runs. All that is not taken should be carefully cleaned up.

Strychnine and sweet corn: sometimes this is recommended, but is dangerous to birds and poultry and should be used with caution. It was used with some success at Thompson's Island by soaking corn in a bucket of hot water in which an ounce of strychnia sulphate had been dissolved. The corn was soaked twenty-four hours, and sugar was added to counteract the bitterness of the strychnine. It should be dried in the sun where no bird or animal can get it. Some of it was taken by rats and some rats were found dead. Dr. Rucker finds that rats will rarely take wheat poisoned with strychnine although squirrels will.

Strychnine and fish: insert in a cut in a small piece of fish as much powdered strychnine as will equal half a grain of wheat (about one-tenth of a grain of the poison by weight). This may be rolled inside the bait, and the pellet placed far down a rat hole.

Strychnine, butter and cheese: Mrs. E. O. Marshall of New Salem, Massachusetts, reports continuous success with cheese treated as follows: two grains of powdered strychnia are spread with butter on a bit of cheese about one-quarter inch thick and an inch square. This amount of strychnine should be sufficient to kill at least ten rats, and probably would kill twenty if divided into equal doses and administered separately to each rat. Half a dozen pieces of cheese thus treated are used in the granary now and then; these pieces disappear quickly, and have so reduced the numbers of rats that where they were formerly to be seen running in every direction now they are

not seen at all. Mrs. Marshall asserts that rats take cheese in preference to grain. Probably the aroma of strong, fragrant cheese disguises the taste of the strychnia until the deed is done.

Phosphorus. — This is perhaps the most widely used poison for rats and mice, and is every effective if properly prepared and used. In an experiment with phosphorus conducted by the Massachusetts State Board of Agriculture the rats disappeared. Many recipes for making phosphorus compounds have been published, but I cannot recommend any of them for general use, as many fires have resulted from the use of homemade preparations.

Professor Lantz says that the phosphorus paste of the drug stores is composed commonly of dissolved yellow phosphorus mixed with glucose or other substances, and that the proportion of phosphorus varies from $\frac{1}{4}$ per cent, which is too small to be always effective, to 4 per cent, which is dangerously inflammable. He has proved by experiment that a commercial phosphorus paste when exposed to sun and rain became so changed that it set fire to paper.

The paste is for sale either as such or under some other name as a rat poison at many drug stores and some grocery stores, and those who wish to experiment with it can obtain it without difficulty. Its odor, unless disguised, usually is something like that of matches, and it shines in the dark, which, no doubt, attracts the rats to it at night. It may be spread like butter on bread or cake, and when swallowed by the rats creates an intense inward burning and thirst, so that if no water is available upon the premises they will leave at once, if possible, in search of it.

Mr. F. L. Hitchings of the State Fish Hatchery at Sandwich, Massachusetts, makes an effective phosphorus poison by placing six bunches of Portland Star matches in about a pint of water that the heads may soak over night. In the morning he stirs into the resulting solution granulated Indian meal, enough to take up the water.

Barium Carbonate. — The Biological Survey, United States Department of Agriculture, recommends barium carbonate as one of the cheapest and most effective poisons known for rats and mice. Prof. David E. Lantz says that it has the advantage

of lacking taste or odor; that it has a corrosive action on the mucous membrane of the stomach if taken in sufficient quantity; that in the small doses fed to rats and mice it would be harmless to other animals, and that its action upon rats is slow, so that if possible they usually leave the premises in search of water. This would appear to be the best rat poison known,[1] but Dr. Rucker of the Public Health Service says: —

> This has not proven an effective poison owing to the fact that it is easily decomposed by the vegetable acids, especially lactic and oleic acid found in cheese and oil. The poisonous effect is not greatly altered by this change. A disagreeable metallic taste is produced and the rats will not take it.[2]

In the experiments conducted by the Massachusetts State Board of Agriculture, rats rarely took this poison, and when it was given to others to try, they reported that rats gave it "the absent treatment." Although they were first fed food preparations without the barium carbonate, they would not touch them after the barium had been incorporated.

Professor Lantz finds this poison effective when prepared as follows: —

> Barium carbonate may be fed in the form of dough composed of four parts of meal or flour and one part of the mineral. A more convenient bait is ordinary oatmeal with about one-eighth of its bulk of the mineral, mixed with water into a stiff dough. . . . The prepared bait should be placed in rat-runs, about a teaspoonful at a place. If a single application of the poison fails to kill or drive away all rats from the premises, it should be repeated, with a change of bait.

Rodwell recommends the following: take a quarter of an ounce of the powder. Make it up, with two ounces of flour or meal, into little balls, like marbles. The addition of two drops of oil of anise seems to make it more attractive to rats, but not to mice.[3]

One difficulty in regard to procuring barium carbonate is that most drug stores apparently do not carry it, and some druggists are likely to "palm off" barium sulphate upon the purchaser,

[1] Lantz, David E., U. S. Dept. Agr., Biol. Surv. Bull. 33, pp. 44, 45.

[2] Treas. Dept., Public Health and Marine Hospital Serv. of U. S., The Rat and its Relation to the Public Health, by various authors, 1910, p. 157.

[3] Rodwell, James, The Rat, 1858, pp. 261, 262.

but the *precipitated* barium carbonate (which is best) should be kept in stock by all leading wholesale druggists. It is an old and well-known rat poison, which apparently has been used with good results by many people.

Directions for Use of Poison in Poultry Houses. — No poison was used in poultry houses in the experiments made by the Massachusetts State Board of Agriculture, as the owners were not anxious to take the risk, several having already poisoned fowls. I cannot recommend anything but rat-proofing for poultry houses, but the Biological Survey recommends the following plan: —

> Two wooden boxes should be used, one considerably larger than the other, and each having two or more holes in the sides large enough to admit rats. The poisoned bait should be placed on the bottom and near the middle of the larger box, and the smaller box should then be inverted over it. Rats thus have free access to the bait, but fowls are excluded.[1]

If strychnine is used the poisoned rats may not be able to get out of the box, or if they leave it they may not get to their holes and may be picked up in the morning and buried to prevent other animals from being poisoned by eating them. There is always an element of danger, however, in using poison in a poultry house, as rats may carry out poisoned food and leave it where the fowls can get it. Mice when poisoned with strychnine are rarely able to leave such a box, and so may be poisoned in the house without much danger of disagreeable results.

General Directions for Poisoning. — Care should be taken in mixing and putting out poisons not to handle them or the food in which they are mixed unless scents are used on the hands, as in the directions for trapping given on page 45. Where rats seem suspicious of poisons it is best to put out unpoisoned material, such as that in which the poison is to be mixed, until the rats have become accustomed to eat it nightly. Then deprive them of it for one night and give them poisoned food the next. Poison should never be left out of doors where birds or domestic animals are likely to get it. If put in rat holes it should be inserted well in with a long-handled spoon. Poisoned

[1] Lantz, David E., U. S. Dept. Agr., Farmers' Bulletin 297, 1907, p. 5.

meat should never be used in such cases, as it may be dug or pushed out by rats or dogs and eaten by dogs, cats or hogs. It is a good plan to dig a long trench in the ground, cover it

Reconnoitering the trench.

with boards, boxes, etc., and feed and poison the rats in this trench. (See cut.)

Antidotes for Rat Poisons. — If one accidentally takes rat poison, get rid of the poison at once by the use of a stomach pump, if a physician is at hand; if not, by the use of emetics. Vomiting may be excited also by tickling the throat with a feather or with the fingers, as well as by the free administration of warm salt or greasy water.

Phosphorus: give an emetic of mustard, a tablespoonful stirred to a cream with water, or, better, blue vitriol, three grains, dissolved in water, every five minutes until vomiting occurs. Give a teaspoonful of old, thick oil of turpentine; also, one-half ounce of Epsom salts in half a tumbler of water, and if there be much pain, twenty drops of laudanum in water. Give no other oil, because this promotes the absorption of the poison.

Arsenic: promote vomiting with copious draughts of warm water or mustard, one tablespoonful stirred to a cream with water. Get from a drug store hydrated peroxide of iron and administer a cupful of it. It may be made by mixing one-half ounce of perchloride of iron with half a tumbler of water and the same quantity of the solution of washing soda. Follow with olive oil or the white of eggs raw, also Epsom salts, one-half ounce to half a tumbler of water; also twenty drops of laudanum in water, if much pain.

Strychnine: give emetics, chloroform inhalations, and chloral

and bromide of potassium. Keep patient warm and quiet; administer strong tea. Give artificial respiration. (Reference Handbook of Medical Sciences.)

Barium carbonate: the antidote is any soluble sulphate, such as Epsom salts, Glauber's salt or alum. This should completely neutralize the poison. (Henry Leffmann.)

In any case of poisoning, a physician should be called as soon as possible.

Rat Deodorants.

Rats sometimes die within the walls of a dwelling whether poisoned or not, and the resulting odor is, to say the least, unsuited to the domicile of civilized man.

A compound of zinc and chlorine, commonly known as chloride of zinc, which has had a reputation for many years as a deodorant, antiseptic and germicide, may be useful at such a time. While the value of this compound may not be great for the two latter purposes it is effective in deodorizing. It is "capable of combining with hydrogen sulphide, ammonia and other offensive products of putrefaction, and forming compounds that are comparatively odorless."[1] It is more effective in neutralizing animal than vegetable odors. "Pickett" says that the following will purify the air in any room: "In one pint of boiling water dissolve half a dram of nitrate of lead; now dissolve two drams of common salt in a bucketful of cold water, then mix the two; dip a good-sized cloth in it and hang in the room."[2] No deodorants have been tested by the Massachusetts State Board of Agriculture, but in case of necessity either of the above may prove satisfactory.

Rat Fumigation.

Carbon Bisulphide in the Burrows. — For killing rats by wholesale in their holes in the ground, in ditch banks, dikes, river banks, levees, shores or dams, carbon bisulphide is the best agent known.[3] Unlike traps and poisons it does not require the co-operation of the rat. Carbon bisulphide is sold as liquid but quickly takes a gaseous form when liberated. It is

[1] McClintic, T. B., Treas. Dept., Public Health Service of the U. S. Hygienic Laboratory, Bull. 22, May, 1905, p. 11.

[2] How to rid Buildings and Farms of Rats and Other Pests of Like Character, 1891, p. 9.

[3] Carbon bisulphide and carbon disulphide are identical.

not expensive when bought in quantity, requires no mixing or apparatus for application, can be used by anybody with ordinary caution, as its strong odor, like that of rotten eggs, immediately gives warning of danger, and is sure death to rats and to most other burrowing animals if properly used under right conditions. It should never be used in or about buildings where there is fire, as it is both inflammable and explosive. In the woods or fields it should be used after a heavy rain, or in winter or spring when the ground and grass are wet. Then there will be no danger of setting fire to grass or dead leaves, and the gas will be more deadly than when the soil is dry, as it will remain in the burrows instead of being dissipated through the minute crevices of the soil.

The following method of applying the gas as used at Thompson's Island was very effective, as it killed practically all the rats in about 400 holes, where it was used experimentally. There the rats burrow in the banks around the high coast of the island, and many of them live in the burrows all the year, as they can find shellfish, garbage, etc., on the beach below throughout the winter, unless the harbor is frozen over, and they store up more or less food in their burrows. The first step in their destruction is to mark each hole by dropping a little plaster of paris at its mouth, and then to determine the number of burrows occupied. This was done by stuffing the mouth of every hole full of grass or seaweed. If a burrow is tenanted the rats are very likely to remove the grass at its mouth within twenty-four hours. In this work the ordinary bee smoker was used as a means of finding all hidden holes. When one hole is found, there are usually others connecting with it, some of which may be unused passages covered by grass, leaves or rubbish which, unless discovered and filled, will allow the gas and the rats to escape. The bee smoker is filled with cotton waste which is set on fire, and the smoke from its smouldering is puffed into a hole to the windward of others, if possible. Soon the smoke is seen issuing from all connecting holes, all of which are then closed with mud or wet earth, except one (the highest, if possible, as the gas readily descends). Then a bunch of cotton waste, grass or similar substance is saturated with one and one-half to two ounces of carbon bi-

PLATE VIII.

FIG. 1. — Smoker ready for use in finding connecting burrows. (Original photograph.)

FIG. 2. — Smoker in operation, showing smoke emerging from connecting holes. (Original photograph.)

sulphide and pushed well into the open hole, which is closed immediately with the wet earth. In the government work on ground squirrels in California only one-half an ounce of carbon bisulphide was used to each burrow, but this was not sufficient on Thompson's Island, where the soil was loose and the rat colonies very large. It might be better in some cases to put one-half an ounce of the liquid into each hole, as the gas does not rise so readily as it falls, and it is conceivable that a much larger quantity of the gas might be needed in a case where the earth is loose and there are many large subterranean galleries. Caution should be used, as occasionally a spark may find its way from the smoker into a hole and ignite the gas, causing a small explosion, but if the grass and leaves are not dry there is no danger of fire, and the explosion serves to drive the gas into all passages and crevices. Some operators prefer to explode the gas in all cases, claiming that it is more effective. Two or three feet of hose and a funnel are used sometimes to carry the liquid deep into the holes. Where rats are very numerous, thousands may be destroyed in this way in a few days by one or two men. A trained fox terrier might be used to advantage in this work, as it would quickly locate early in the morning the burrows where rats had recently run in.

Dr. John D. Long of the Public Health Service has invented a machine for forcing carbon bisulphide into burrows which he claims economizes the gas.[1]

Other Fumigants. — In buildings hydrocyanic acid gas is destructive to all animal life, including insects, but is expensive, and so dangerous to human life that great care must be used in applying it. If used where rats can conceal themselves in the walls they may die there, with the usual disagreeable results. The method of preparing and using this gas is given by Dr. L. O. Howard in Circular 46, Bureau of Entomology, United States Department of Agriculture, 1907.

Carbon monoxide, chlorine and sulphur dioxide are used in fumigating ships to destroy rats and insects. Of these, sulphur dioxide is the safest, and is also used to extinguish fires. The two former are not recommended, the first because it is odorless, and may kill before the odor is detected; the

[1] Public Health Reports, Vol. 27, No. 39, Sept. 27, 1912, p. 1594.

other because it has a strong bleaching action on textile fabrics. Sulphur dioxide has a less marked bleaching action, and is recommended by the public health authorities for fumigating ships for the purpose of destroying rats to prevent the introduction of bubonic plague. Port regulations prescribe its use, and steamship companies provide vessels with special apparatus for generating the gas. For directions for fumigating vessels with sulphur see Public Health Reports, June 20, 1913, "The Fumigation of Vessels for the Destruction of Rats," by S. B. Grubbs and B. E. Holsendorf, and "The Rat in Relation to Shipping," by Wm. C. Hobdy, published in "The Rat and its Relation to the Public Health," by various authors, Public Health and Marine Hospital Service, Treasury Department of the United States, 1910, page 211.

Rat Viruses.

The Massachusetts State Board of Agriculture has not experimented with any bacterial infection, but has interviewed many people who have done so, and only three have reported satisfactory results. Careful experiments have been made with viruses by scientific investigators in this country, and the general verdict seems to be against their effectiveness.

Dr. M. J. Rosenau, Professor of Preventive Medicine, Harvard University Medical School, has made many experiments with various viruses advertised commercially. He has experimented with the bacillus obtained by Danysz and the commercial cultures known as ratite, azoa and ratin.

In the laboratory some of these viruses have been effective to a considerable degree under favorable conditions, but Dr. Rosenau does not recommend them for general use for the following reasons: (1) "Rats are notoriously resistant to bacterial infection." (2) The Danysz virus, which is pathogenic for rats under laboratory conditions, has feeble power of propagating itself from one rat to another; it quickly loses its virulence, especially when exposed to outdoor conditions; the other viruses have proven even less satisfactory in this respect. (3) The claim that these rat viruses are harmless to man needs revision, in view of cases of sickness and death resulting from their use reported by various observers.

Under natural conditions these rat viruses appear to act somewhat like a chemical poison. They have, however, these great disadvantages: they are comparatively expensive, and when taken in small amounts or after they have lost virulence they render rats immune.

The Biological Survey of the United States Department of Agriculture in co-operation with the Bureau of Animal Industry has experimented with ratin in both laboratory and field. The material (ratin No. 2, labeled "Trans-Atlantic Ratin") was furnished by the American agents in New York. This was claimed to be a bacterial preparation which would kill for six generations, but according to Dr. Rosenau, Professor Lantz says that it proved to be a glucoside poison (probably squill), and that it contained no bacteria.

Squill is an effective rat poison, and this proved to be such, although in some of the experiments a considerable percentage of the affected rats recovered, and subsequent attempts to kill them with this material failed. More than 100 rats were used in the experiment.

Dr. Rosenau says that the effect of this ratin is not communicable, as it is a poison and not a virus.

Ratin No. 1 (a real bacterial culture) was fed to rats and produced no apparent result. Several trials of azoa for the destruction of rats have been observed by the members of the Biological Survey. In some of these cases no results were noted. In one there was some measure of success. Experiments with the various rat viruses during the outbreak of the plague in San Francisco gave unsatisfactory results.[1]

Dr. C. H. Townsend recently has published in "Bird-Lore" a report of success with the so-called Pasteur virus, but in reply to an inquiry he writes now that the second trial was disappointing. Dr. Rosenau writes that he now sees no reason to modify his conclusions as given above. Scientists may yet find a virus that will be effective under ordinary conditions, but thus far the efforts in this direction seem to have met with disappointment.

[1] The Rat and its Relation to the Public Health, by various authors, Treas. Dept., Public Health and Marine Hospital Serv. of U. S., 1910, pp. 186–188. See also Lantz, David E., U. S. Dept. Agr., Biol. Surv. Bull. 33, 1909, pp. 50, 51.

Rat Shooting.

Many rats have been killed with small bore rifles, but the surest and deadliest weapon is the shotgun. A thin straight line of grain or ground fish should be laid on the ground directly toward a door, window or loophole at which the gunner stands. When the rats have become accustomed to come out late in the afternoon or early in the evening to feed on the grain or fish, the shooter takes his stand, and, waiting until they have grouped themselves in line with their heads together on the bait, fires down the line. If they do not come to feed until after dark the gun may be lashed or clamped to the building in such a way as to "enfilade" the line. Then it will be only necessary to pull the trigger when by the light of a "bullseye" lantern or an electric torch it is seen that the rats are ranged properly. This method, with a cautious approach, has been successful, but no "set gun" should be left loaded. The charge of powder should be as heavy as the gun will carry, the shot No. 8 or 10, and the distance not over twenty yards.

Rat Drowning and Clubbing.

At The Farm and Trade School on Thompson's Island, where the boy pupils are taught to kill rats, as all boys should be, there is a henhouse built with a cement foundation, but it has an earth floor and no foundation wall on the south side; therefore it is not rat-proof. The wooden floor of the main house is raised about three feet above the earth, leaving a space below it for a shelter for geese. Here the rats have burrowed in the earth, and as it was considered unsafe to use carbon bisulphide there on account of the fire danger, water was suggested. Two lines of common garden hose were attached to a near-by hydrant, the ends inserted into rat holes and the water turned on. All rat holes leading from the henpens to the outer world were closed with earth, and several boys were provided with sticks, to the end of each of which a piece of hose two feet long had been attached. A fox terrier was introduced into the henpens, and in about half an hour the rat war began. As the half-drowned rats came out of their holes somewhat dazed they were struck by side swings of the hose sticks, which knocked

PLATE IX.

A Useful Occupation for Boys.

Every boy has a rat. These rats were killed under the henhouse shown, by pupils of The Farm and Trades School on Thompson's Island. Each boy was provided with a flat shovel, or a stick with a piece of old hose on the end. (Original photograph.)

PLATE X.

Results of Rat Drowning and Clubbing.

Forty-six rats killed about a small henhouse on Thompson's Island in one afternoon. (Photograph by Mr. Chas. H. Bradley, Superintendent of The Farm and Trades School.)

them off their feet, to be killed by other blows. If one escaped into the henpens, boy or dog killed it. This operation was repeated later from time to time. Four successive battues several weeks apart yielded 152 rats from under and about this henhouse, and no doubt many young rats were drowned in their nests. Where no high-pressure water main is available burrows on the banks of pond, river or ocean might be cleared in this way by means of a powerful sewer pump and hose.

RAT ENEMIES.

Hawks, Owls, etc.

One cause of the increase of rats is the destruction of their natural enemies by man. In a country where game preserving becomes general, and hawks, owls, weasels and other so-called vermin are killed off, rats often become so numerous and destructive as to be more troublesome than all the other predatory creatures. Minks and weasels are far more effective as rat killers than the domestic cat, as these bloodthirsty animals are so thin and snakelike that they can follow the rodents to their nests, where the cat cannot go. Some of the larger hawks kill many rats in summer when rodents get out in the fields before dark, and the owls are the most useful of all ratters. The large owls take full-grown rats, but the smaller species can master only young rats and mice, of which each owl probably destroys many more annually than many cats. Dr. A. K. Fisher of the Biological Survey found about the nest of a pair of barn owls the skulls of 172 brown rats, 452 house mice and 128 field mice. The ground about a barn owl's nest in the Bahama Islands was covered with pellets containing rats' bones and fur. O. E. Niles states that he counted 113 dead rats at one time under the nest of a great horned owl.[1] Skunks are excellent ratters. A pair which burrowed underneath a large camp cook house soon cleared it of all rats and mice. If poultry is properly housed, skunks rarely do any damage, and they are very useful about a farm. A family of skunks remained in and about my henyards one season and

[1] Treas. Dept., Public Health and Marine Hospital Serv. of U. S., The Rat and its Relation to the Public Health, by various authors, 1910, p. 165.

destroyed numberless insects and never harmed a person or a chicken, although I have known disagreeable consequences to both persons and chickens to ensue under different circumstances. Many large snakes kill rats.

The Cat.

Almost without exception rat catchers and writers on rats and their habits belittle the cat as a rat catcher. The consensus of opinion seems to be that while most cats catch mice, very few care to attack a full-grown brown rat. My own experience is somewhat at variance with this opinion. I believe that many stray or feral cats catch rats, and that some farm cats are fairly good ratters. The number of rat-catching cats in the city or town may be smaller. Many Massachusetts farmers rely chiefly on cats to keep their premises free from rats, but rarely, so far as I have been able to learn by actual observation, do they free their owners' buildings and grounds absolutely from the rodents; nevertheless, in some cases they keep down the increase.

The best ratter I ever observed was kept as an experiment, and caught about one rat a week on the average in and about my farm buildings for the nine months that she was kept under observation. She might have caught more had rats been more numerous there. Rats were seen often before the cat came; after her advent they rarely were seen or heard. They disappeared from the house for the time being and rarely came back, but a careful search for tracks and signs showed that they were as numerous as ever in and about the barn, and occasionally one entered the house but soon was caught. At the end of nine months eleven snap traps were set one night in the barn and the cat shut out. Some of these traps were old, rusty and nearly worthless, but the next morning four rats were found dead in the traps, two traps had been dragged away, and two more traps were sprung but ratless. Later, two more trapped rats were found dead. Thus, six rats were trapped at once in a building where the cat had been given every opportunity to catch rats for six months, and, had the traps been new, probably two or three more might have been taken. The cat never got more than three rats in one day,

PLATE XI.

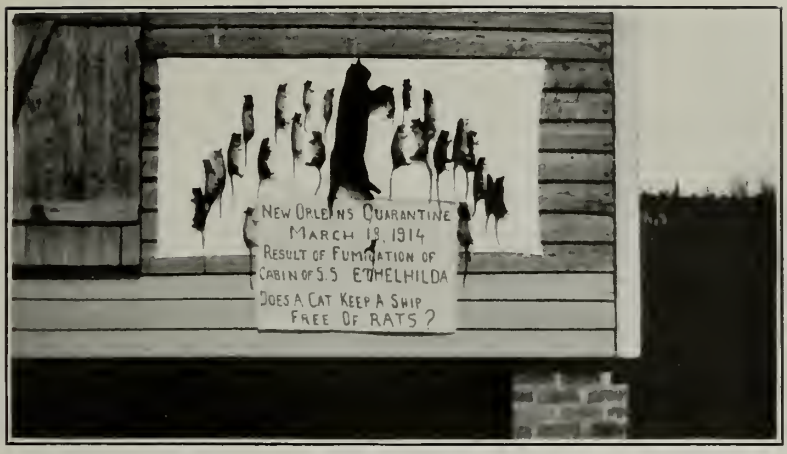


FIG. 1.—AN ILLUSTRATION OF THE INEFFICIENCY OF THE CAT AS A RAT CATCHER.

One cat and twenty-four rats as the result of fumigation of the cabin of a steamship. This cat was an exceptionally good ratter and was supposed to have kept the cabin free from rats. In fumigation she was overlooked by accident. (From Public Health Reports, Vol. 29, No. 16.)

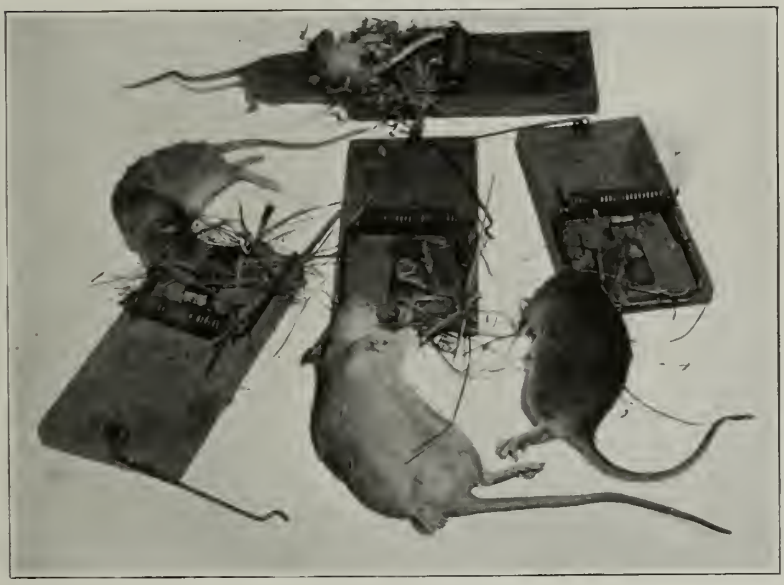


FIG. 2.—THE CAT FAILED.

Four out of six rats taken in 10-cent traps in the author's barn in one night, after rat-catching cat had been in same barn for nine months. (Original photograph.)

and these were enticed outside the barn for her convenience. Probably fifty rats could have been trapped in that barn in two weeks — after the nine months' work of the cat. Mr. Wilfrid Wheeler had a cat that at one time averaged two rats a day for a week, but the rats were so numerous there that the cat made no visible impression on their numbers, and finally poison was resorted to. The two cats above named may be considered excellent rat catchers.

The following, from Surgeon G. M. Corput in the United States Public Health Reports, shows how little dependence can be placed on the cat as a rat exterminator: —

> Every quarantine officer is familiar with the old plea of shipmasters that there is no use of fumigating the cabin of a vessel because there is a cat on board which is an excellent ratter and renders it impossible for rats to live in cabin. The enclosed pictures are the result of not believing this story. The British steamship "Ethelhilda" arrived at this station [New Orleans Quarantine] March 18, from the west coast of Africa. The captain assured me that it was impossible for any rats to be in the cabin of his vessel because of the presence of an exceptionally good cat. The cabin was nevertheless fumigated. Through the irony of fate the cat was forgotten. When the cabin was opened up the enclosed picture shows the result. Every part of the ship had many rats. The picture is limited, however, to what was found in the cabin, — one cat, twenty-four rats.[1]

A rat-catching cat no doubt tends to drive rats away from the dwelling where it is domiciled to some other place where such cats are not kept. Nevertheless, if rats have good harborage and a plentiful supply of food, they often remain and increase in spite of the best of cats. For this reason many farmers are not content with one cat but keep a number, which they find more effective than one in keeping down the rat population. It costs very little to keep cats if they are fed only the "strippings" at milking time, and are allowed to pick up their own living otherwise. In this way from three to forty cats are kept on some farms, some of which are worthless as rat catchers. In such cases there is doubtless a great indirect loss to the farmer in the number of insect-eating birds that the cats destroy, which if it could be reduced to dollars and cents

[1] Public Health Reports, Vol. 29, No. 16, April 17, 1914, p. 928.

would surprise him. Probably in most cases two selected efficient cats would do about all the rat killing that cats can be expected to do on the ordinary farm.

A wholesale grocer found his store most free from rats when he kept fourteen cats, but he had to dispose of the cats, as they did about as much damage as the rats and ate more.

The cat is unnecessary as a mouse catcher, for all mice may be trapped with the greatest ease. I never was able to get rid of the rats in my town house until the cats were disposed of, as traps could not be set freely without danger to the cats. After the cats had gone it was easy at once to trap any rats that invaded the place. Those who keep cats can help them to kill rats by baiting rats outside the buildings in the open, and making a place for the cat where it can watch from above and pounce down on them.

To sum up: by selecting cats carefully and keeping them in sufficient numbers rats may be held in check or driven away. Selected cats are serviceable to people who are too busy, ignorant, indolent or indigent to destroy rats. These classes include a large part of the population. Hence the prevalence of cats. The best ratters are small-sized female brindle or tabby cats, with small heads and large ears, but black cats sometimes are equally useful.

The Dog.

The ordinary farm dog or pet dog is of little use as a rat catcher, but the Airedale and some of the smaller terriers are good ratters, and if not overfed and pampered they may be trained to a high degree of efficiency. The fox terrier cannot be excelled as a rat hunter. A single terrier has been known to kill more than a thousand rats in a year. I recently saw an ordinary untrained fox terrier catch and kill four large brown rats in an hour in open fields one moonlit evening. Had she been trained she might have killed two more that escaped. Probably no cat ever lived that could have covered the same ground and taken four rats in one hour. The cat sometimes spends days watching for a single rat and then misses him. One advantage of the dog is that it can be trained to assist man and to accept man's

assistance, where the cat cannot. The dog is fearless and active, wastes no time torturing its prey, and can kill as many rats an hour as it can get hold of. Where rats are very numerous, man, dog and ferret working together can destroy great numbers in a short time.

The Ferret.

Many people whose premises have been overrun by rats have obtained ferrets to drive them out. The ferret, like the weasel, can follow the rat into its holes and runways, and where rats are not too numerous and vicious they will fly from a ferret and leave the premises, but when the ferret has gone they come back; where rats are very numerous they may attack and even kill the ferret. But when two or three courageous ferrets and a bright fox terrier have been trained by their master to work together, the rats can be driven from their holes and caught by the dog, and thus a rapid deratization is effected. Even then, rats if very numerous may drive or kill a ferret, and ferrets are sometimes killed by accident or mistake in the hunt. Those who wish to keep ferrets will find directions for training them in a volume entitled "Studies in the Art of Ratcatching," by H. C. Barkeley, London, 1896.

I prefer the quieter, surer method of the trap to the use of any domestic animal.

RAT DRIVING AND HARRYING.

Many ways for driving rats out of buildings have been recommended. Some of these, like the old plan of writing a letter to the rat, may appeal to the superstitious, but are worthless so far as relief from the pest is concerned. Others are harmless commercial compositions manufactured and sold to deceive the credulous. Others actually seem to be of some service, but none will drive rats away permanently. It is far better to use some means to destroy the rat than to drive him to the premises of one's neighbor, whence he is likely to return in time with reinforcements.

Nevertheless, hunting, harrying and driving rats will tend to discourage them from settling permanently, and there are

circumstances at times which make it desirable to evict rats temporarily from a certain spot.

In the experiments undertaken by the Massachusetts State Board of Agriculture, it became necessary to fumigate a large number of rat holes in a bank, but near by there was an old dike partially timbered which was so loose and open in texture that the scores of rat holes there would not confine any gas long enough to destroy the inmates, and when the rats in the bank had been killed off, it was soon populated again by the overflow of rats from the dike. Hence it became necessary to drive these rats to the burrows in the bank before it could be cleared.

Among the measures often recommended to drive rats away are: —

1. Sewing a red jacket on a rat (or painting him) and then liberating him.

2. Pouring kerosene over a rat and setting him afire, then liberating him after the fire has burned out. This horrible cruelty is supposed to frighten other rats away. Needless to say we have not tried it.

3. Placing a collar and bell on the neck of a live rat. Several observers have tried this and all report that it drives rats out of a dwelling or barn.

4. Dipping a rat in tar and releasing him. This has the same effect as the following.

5. Tar placed in all rat holes, runs and burrows. Rats dislike the smell of tar and its stickiness. This drives them, for the time being at least, from holes so treated. Also, they are not fond of turpentine. When in passing they rub either of these liquids upon the hair, their attempts to lick it off produce dissatisfaction with their defiled burrows.

6. Chloride of lime, loose or wrapped in old rags, placed in burrows. Several experimenters who have used this report success.

7. Crude carbolic acid, moist caustic potash or powdered red pepper placed in runs and burrows. (Carbolic acid will drive rats, but just now (October, 1914) it is very expensive.)

8. Feeding the rats oatmeal or flour mixed with plaster of paris.

The use of plaster seems to produce no effect if the amount used is small, while if a larger quantity is used the rats apparently do not eat it. But Professor Lantz tells me that in the experiments of the Biological Survey rats ate and digested freely plaster mixed with flour and meal in varying quantities, and that they also ate without inconvenience pieces of cork and sponge that had been fried in lard. Nevertheless, many people seem to believe that they have secured good results by the use of these methods.

Others report success with freshly slaked lime placed dry in all burrows and runs, freshly made hot thin whitewash poured in the burrows, and from a strong solution of copperas (ferrous sulphate) sprinkled in runs and burrow entrances.

Any or all of these proceedings tend to make life uncomfortable for the rat, and one or the other will reach and defile his domicile under nearly all circumstances. To drive out rats, one after the other of these agents might be used, beginning with chloride of lime or carbolic acid, but the surest way to get rid of rats is to starve them and pursue them with traps and poisons until the last one is dead, or, weary and affrighted, he takes his melancholy way to some more hospitable abode.

The plan that ordinarily succeeds best in driving rats from dwellings is to get most of them by carefully set traps, and if loneliness and apprehension of evil does not discourage the last one to the point of emigration, a little poison skillfully administered usually destroys it or causes it to make up its mind over night to depart.

CO-OPERATIVE RAT KILLING.

Co-operation in the destruction of rats like co-operation in most other matters is conspicuous by its absence in America, but co-operation is required to abate the rat evil. Under present conditions a farmer, householder or merchant may keep his premises clear of rats, but only through constant effort, because his neighbors make life pleasant for them and allow their increase to wander back to his premises. In England co-operation has made some headway. Rat clubs have been formed, giving prizes or bounties for rat destruction, and so ridding their own communities of great numbers of rats at

little cost. Municipal employees have been required to hunt rats. Organized work in European cities has given excellent results.

In England a national society for the destruction of vermin has been incorporated, and a great international society for the destruction of rats has been organized in Denmark, which has had good influence there and in other countries, but so far as I know nothing of the kind has been attempted in America.

These societies have secured the destruction of enormous numbers of rats. In Denmark a government appropriation has been granted for the payment of bounties.

Side hunting, a relic of barbarism, which still persists in some parts of the United States, might be directed against rats rather than against useful song and game birds. A party of hunters choosing sides might hunt rats and thus benefit themselves and the community at large and at the same time enjoy the sport of hunting. Let rats be the only animals that count in the contest. This has been tried in some localities with excellent results (see page 15). May 2, 1909, was set aside in one of the counties of Kentucky as a day for killing rats, and was quite generally observed.[1]

A great national organization, with State branches, should have been formed long ago in this country to encourage the destruction of rats, to disseminate reliable information regarding rat riddance and to organize continuous systematic warfare against the pernicious rodents. Such an organization would have generous support if rightly launched, and might establish a deratization propaganda that would save millions of dollars and many valuable lives. Assistance might be secured from State and national governments, and the organization might become important and useful in our national life. The mayor of Boston now advocates requiring the rat-proofing of buildings. Dr. J. R. Hurty, State Health Commissioner of Indiana, proposes to the business men of Lafayette, Indiana, that all rat-producing conditions be abolished in that city, and that a city ordinance be passed declaring the rat a nuisance, and assessing, after a given period, a fine of $5 per rat against property owners on whose premises rats are found. The public is beginning to awaken to the rat danger.

[1] Lantz, David E., U. S. Dept. Agr., Biol. Surv. Bull. 33, 1909, pp. 51–53.

SUMMARY.

The rat has become the greatest rodent pest ever known. It is more destructive to property and more dangerous to human life and health than any other animal. There is no panacea for the rat scourge, no one method that can be relied upon alone to exterminate rats. They should be starved and evicted by rat-proofing buildings, drains, food and garbage receptacles, and burning garbage or rubbish in or under which they feed or breed, and by quickly threshing and marketing all grains or storing them in rat-proof buildings. Then, suffering the pangs of hunger, their breeding places destroyed or exposed, they may be readily trapped, poisoned and shot, or harried by man and their natural enemies. Fumigation of burrows with carbon bisulphide is exterminative where conditions are favorable for its employment. The so-called animal viruses, Pasteur viruses, etc., are expensive, and apparently not efficient enough in practical service to warrant their general use. Co-operative efforts with all effective methods and continual persecution are required to abate the rat evil.